VOL. LIII. — No. 2

Municipal Engineering

The World's Leading Municipal Publication

AUGUST. 1917.

A GOOD TIME FOR COST-PLUS CONTRACTS

Under stress of war conditions the Army and Navy Departments of the federal government are leaning heavily upon the cost plus a percentage plan of awarding contracts. While this action is based primarily on the imperative need of rapid preparation, which leaves scant time for advertising for bids, etc., it is doubtless based in part also upon the desire to proceed at a minimum of expense by eliminating much of the hazard always present in contracting work and intensified under war-time conditions. Is there a suggestion here for the guidance of civil authorities charged with the responsibility of awarding contracts? There is.

The merits and shortcomings of the "cost-plus" plan under peace-time conditions are well understood. While attractive in many ways, notably because it reduces the hazards to which the contracting business is subject, the plan has not been widely adopted because it tends to eliminate competition and to discourage efficiency for the sake of economy. The plan ordinarily makes for higher costs, tho it may produce better results. There are always contractors willing to gamble on the weather, soil conditions, ground water, etc., who figure themselves sure to get a good break all the way thru the job. Such men are the low bidders and they get the jobs. Under ordinary conditions construction is undoubtedly carried on at lower costs under the free bidding plan than under the "cost-plus" plan.

When to all the uncertainties which plague the contractor at the best of times are added other uncertainties peculiar to war times, it should be apparent to the least discerning contractor that his bid must have an ample factor of safety in it. He is likely to bid very high to protect himself against all the contingencies at all likely to arise. He will strive to protect himself against labor shortage, violently fluctuating material supplies and costs, etc. He will almost surely figure his costs too high in war times, just as he is prone to figure them too low in ordinary times. He will become over-cautious and his bids will be proportionately above normal.

Reasoning from the premise that no community wants to stick a contractor, much less drive him into bankruptcy, isn't it only fair to conclude that in times of abnormal hazard the community should assume the risks? The cost-plus plan would seem to safeguard the interests of all parties in these times. A wide adoption of this plan will make for a maximum of construction during the war.

BUY LABOR-SAVING MACHINERY NOW

When labor-saving machinery was new in the construction field it had many prejudices with which to contend. It is no joke to say that many contractors were opposed to such machinery for political reasons. A gang of one hundred men had one hundred votes for the contractor's candidate, while the machine that chased these men off the job couldn't vote at all. What chance did the machine have?

Then there was that age-old prejudice against a machine of any kind, be it a sewing machine, a cotton gin or a tamping machine, that was brought out to supplant labor. The inventor of the sewing machine came mighty near getting lynched, down Boston way, for putting a lot of tailors out of business. So far as we know, no manufacturer of contractors' labor-saving machinery has been mobbed, but such men are likely to be bombarded at any time—with orders for the machinery.

There is a labor shortage in this country right now and it has been with us for months. The labor shortage will certainly become much more pronounced when the draft law gets to working. And that isn't all. Canada and France are both appealing for American laborers, and are getting some of them, too. They will get more later on. Our own military labors, back of the lines, will require skilled and unskilled laborers by the thousand.

Clearly this is the time for contractors and constructing engineers to buy labor-saving machinery. Our labor shortage is probably only beginning. It will doubtless continue after the war and may very easily be worse then than now. It appears likely that more aliens will leave this country than will be replaced with immigrants at the close of the war. Europeans who survive the war will stay at home to rebuild their wasted cities and public works. Their countrymen who have been sojourning with us will go back home to help in the building of a new Europe, to visit and to view the ruins.

It is a safe forecast that we will have a labor shortage in this country for some years to come. In addition to what we have enumerated, new lands are being opened up which will be farmed after the war. Our growing foreign trade will keep on growing and will call for more and more labor. We will also have our war losses.

American contractors have never had an easier decision to make than that they should buy labor-saving machinery now.

STREET AND ROAD PAVEMENTS

THEIR DESIGN, CONSTRUCTION AND MAINTENANCE

(Continued from July Issue.)

Description of progress, including points on best practice in concrete road construction, as based on knowledge gained by inspection of concrete pavements in various parts of the country.

"If the best concrete roads are to be constructed," states Mr. A. N. Johnson, consulting highway engineer, Portland Cement Association, "more attention must be paid to the nature and character of the concrete. Definite proportions having been adopted for the cement and aggregates, the quantity of water plays the most important part in the strength of the resulting concrete.

"The problem before the practical road builder is how to secure as nearly the right amount of water as possible. Owing to the variation that exists in the aggregates, it is difficult to secure the precise amount of water that will give the maximum strength with a given amount of cement and aggregates. Moreover, as the exact amount of water for maximum strength gives a rather stiff constituency, there is the practical difficulty to get the foreman in charge of the work to use such stiff mixtures. Therefore, it is necessary to use a small surplus of water in order to manipulate the concrete readily and work it in place. This excess of water, however, can be corrected to a large degree by the subsequent manipulation which the concrete receives.

"All who have examined the concrete pavements laid at Sioux City, Iowa, and Macon, Ga., have remarked upon their uniform excellence. This excellence is not to be accounted for alone by the fact that good aggregates were used, or that soil conditions were peculiarly favorable because good aggregates have been used in many places and the soil conditions in Sioux City and Macon present a variety of conditions.

"There is, however, one outstanding feature in the construction of the pavements at both of these places, which in the opinion of the writer, is the chief cause for the uniformly excellent results obtained, and that is the concrete is so manipulated that the excess water it contains is removed.

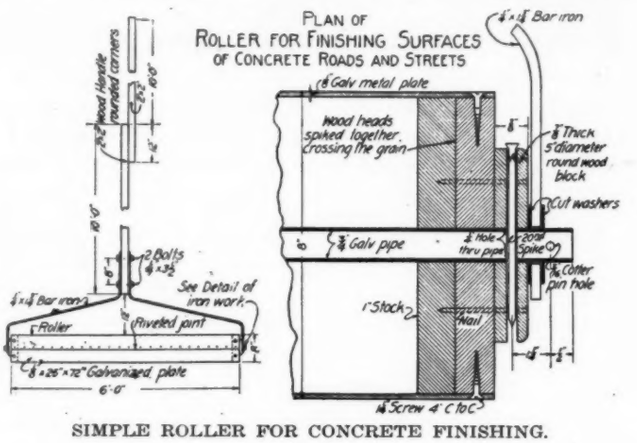
"The method used to accomplish this in Sioux City, while effective, is more expensive and not as satisfactory as the method developed in Macon, Ga., by Captain J. J. Gaillard, city engineer. Captain Gaillard's method consists of rolling the concrete with a light hollow sheet steel roller about 6-ft. long and 8-in. in diameter, in which are inserted wooden ends supporting an axle, to which a bail is attached carrying a long handle. The details of such a roller are shown in accompanying sketch.

"The manipulation of this roller is as follows: Immediately after the concrete has been struck, or placed, it is rolled by moving the roller transversely across the street or road. In case of an exceptionally wide street the handle is long enough to reach a little more than half way across the pavement. On a narrow street or ordinary country highway the handles will be long enough to enable the workmen to roll the entire width of the road, working from one side.

"The effect of the roller is that of a rolling squeegee—it consolidates the top layer of the concrete and removes practically all of the surplus water. At the same time, it takes out the slight uneven places in the surface which may occur, particularly if the pavement has not been struck by a template. The rolling should be continued until free water ceases to come to the surface, when it is ready to be finished by the canvas belt. The effect of the belt is to give uniform, gritty texture to the surface."

Measuring the Wear.

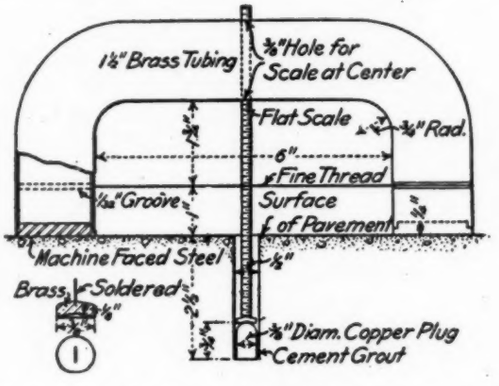
"With the use of rigid types of pavements or pavements which rest upon a rigid base, the methods that have been devised for measuring the wear of macadam roads are open to considerable error, aside from usually clumsy. Most of these devices provided for reference points at the sides. But where the pavement consists of a rigid slab or rests upon one, the observations that will be secured from a straightedge or wire stretched across the road are often quite useless, due to the movement of the slab and the possibility of its fracture because of unequal settlement. The method here proposed will overcome such difficulty and is also extremely simple and convenient.



SIMPLE ROLLER FOR CONCRETE FINISHING.

Wimple Device for Measuring Wear of Concrete Pavements.

A drill hole ½-in. in diameter is made in the pavement. In the case of a concrete pavement, it may be 2 or 2½-in. in depth. In the bottom of the drill hole is set a copper plug about ¾-in. long, with its top made semi-spherical. The plug is imbedded in the hole with cement paste. A short steel scale divided into inches and hundreds, small enough to be placed in the drill hole, is provided. At its end is a small button with conical undersurface, which is to rest on the



DEVICE FOR ACCURATE MEASUREMENT OF WEAR OF CONCRETE SURFACE.

spherical end of the copper plug. Across the surface of the pavement bisecting the drill hole is stretched a fine thread, and measurements are made with a scale. The hole is then filled with a wood plug, left flush with the surface, which is to be removed when subsequent readings are to be made.

A better and probably more convenient method would be to have a U-shaped handle, which will span about 6 in., having flat ends on the legs. Drawn between the supports is a tightly stretched thin thread or wire 1 in. from the surface of the pavement. This is to be held so that the thread will be over the center of the drill hole. The flat ends of the legs rest on the pavement surface and the measurements are made to the thread. The fact that the thread is raised above the pavement will make it possible to read the scale more conveniently, and is an easy method of holding the thread. The bridge or U-shaped handle holding the thread may first be placed longitudinally with respect to the pavement, then transversely, and in as many other positions as desired, the average of all readings is taken. The handle may be made of hardwood, with metal-shod legs, or of a bent hollow brass tube about 1½ in. in diameter.

This simple method will give, it is evident, data from which the exact wear at any point of pavement is desired. A line of drill holes, spaced about 15 in. apart, at various places in the pavement, would give sufficient data to determine the variation in the wear at different points. In the case of concrete pavements these data would be of special value to determine what influence variations in the materials of the concrete had upon the wear. The accompanying sketch illustrates the apparatus.

Machine Finished Surface

"The striking and finishing of the surface of a concrete road or pavement is an operation which demands the exercise of intelligent and painstaking labor," states Mr. M. DeGlopper, County Engineer, Oakland County, Mich.

"Its hard, unyielding surface cannot be altered after construction; any depression and unevenness of the surface, which is sure to follow crude or improper finishing, always remains. These not only result in discomfort to the traveling public, but a greater degree of wear results if the surface is uneven.

"Contractors must understand that good workmanship means better prices. No community will stand being 'stung' more than once, and in the future the competent, painstaking road builder will find his services in ever increasing demand.

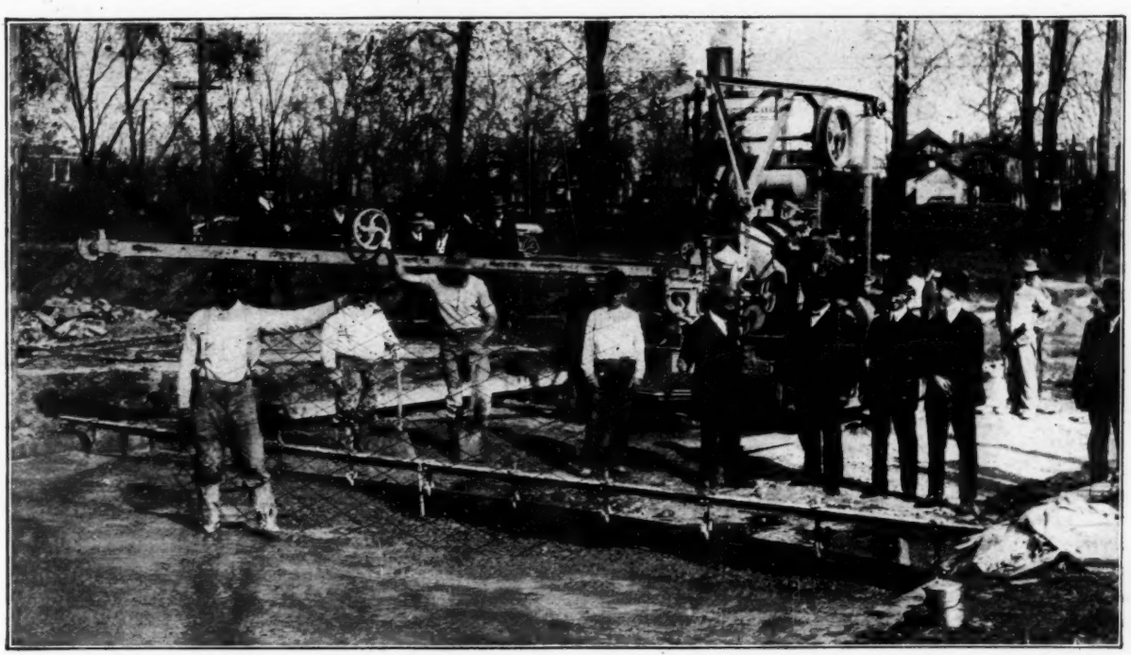
"The first essential in getting a good finished surface on a concrete road, whether hand or machine finished, is the right kind of side forms, and the placing of them to the exact grade. If they are too weak, so as to bow out between stakes, the pavement will sag, causing a depression at the crown. If they are warped vertically, a rise or fall will occur at the centers and where they join. Get the best side forms and keep the concrete off the top of them.

"If finished by hand, the next important thing is the strike. It not only must be strong, rigid and durable, but light enough to be operated by as small an amount of labor as possible. Rigid to retain the desired curvature and withstand the pressure of an accumulation of concrete. It must be shod with steel on the under side, where it is curved to the exact crown of the road.

"Here it might be stated that a circular crown to a road or pavement is the easiest thing to produce. If the attempt is made to make a parabola top (one that is flatter at the crown and the curvature increases more abruptly toward the edges), with a strike having that curvature on the under side, it must be pulled straight ahead, as any sawing of the strike over the side forms, as is usually done, will result in a deformed surface. The circular crown permits the strike to be drawn back and forth without changing the crown.

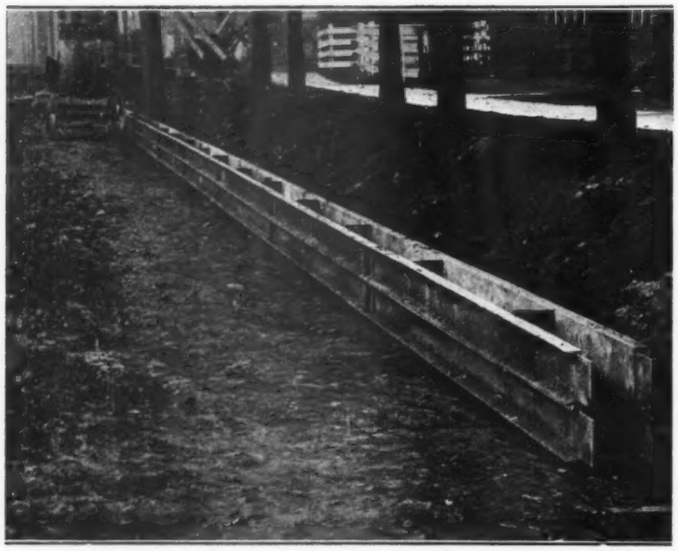
"Strikes for wide construction, 20 ft. or more, require a man at each curb and at each quarter to assist in pulling the strike forward by means of light iron rods hooked to the strike. The general method is to pull it slowly forward and at the same time work it transversely back and forth with a sawing motion. This must be repeated a number of times to produce satisfactory results.

"The finishing of the road or pavement by hand is a delicate operation. More concrete surfaces have been ruined by inefficient handling of floats and trowels than any other way. Floating must be done from a bridge, as the depression left by plank laid on the soft concrete or the track of the workman will be floated full of soft material by the finisher, and depression will result.



BUSH AVE., BELLEVILLE, ILL. 27 FT. WIDE, REINFORCED WITH KAHN MESH. ARMOR PLATES AT INTERVALS OF 34 FT. REED BROS., CONTRACTORS; W. C. WOLFE, CITY ENGINEER.

"The purpose of floating is to smooth out any unevenness which may appear after the strike has passed over it. Hand floating is expensive and a source of constant annoyance to the contractor, who usually cannot get finishers sufficiently skilled to produce a smooth, even surface. To overcome their difficulties and to permit the making of a more perfect wearing surface than could heretofore be obtained. we operate a Baker Automatic Finishing Machine.



CURB FORM SET UP READY FOR POURING CONCRETE. THESE FORMS MAY ALSO BE USED FOR COMBINED CURB AND GUTTER OR AS SIDE FORMS FOR ROAD.

"Perhaps a better idea of the advantages of this machine can be drawn by means of a comparison between the hand and machine methods of finishing. First, consider the merit and concrete requirements of the old method (hand strike and finish):

1. A very wet and even sloppy consistency of concrete is usually maintained in an attempt to force the filling of the voids. This leaves many weakening invisible pores, increasing the possibility of high moisture content.

2. A very wet mix is necessary to provide sufficient time for tamping, striking and floating before the initial set takes place.

3. The wet mix, when used, produces a wavy surface, especially on grades, the tendency being for the mortar to creep away from the crown to the sides or bottom, leaving a flattening effect. This is contrary to specifications, but is unavoidable with a wet mix. Most specifications require a concrete to be so plastic that it will flush readily under light tamping and at the same time be so dense that there will be no separation of the mortar from the aggregate. This is inconsistent. One condition or the other must prevail.

4. Hand striking and floating is slow, tedious and expensive work, requiring at least four or five men for this part of the work.

5. Inability to finish the surface as fast as the concrete is placed on the sub-grade very often results in the necessity of retempering the surface for smooth finishing. This retempering, resorted to after the concrete has started to set, very often destroys the bonding characteristic of the cement and causes rapid wear and dusting on the surface.

6. Hand floating leaves a deceiving surface. It may appear to be smooth, but the presence of numerous small depressions is discernible upon the evaporation of the water. Quite often, while the floating is being done, these depressions are replenished with a little additonal concrete or mortar. This does not leave a proper bond between the depression already floated and the added material, which is liable to form a crust.

7. In hand tamping, as usually performed in conjunction with the striking, the compressive force can only be applied to a very small surface at a time. As soon as the tamp or strike is raised, the mortar and excess water rush into the depression formed, leaving a surface which is not uniform in consistency.

8. The principal reason for advocating a wet mix is that no tamping will be necessary, and consequently the workmen will not be compelled to walk on the concrete. The advocacy also implies that the weight of the material and fluidity of the mortar will furnish the required density.

9. The placing of an excessive amount of concrete results in the riding of the strike and increases the labor in floating and the attending chance for surface waves.

10. To secure satisfactory results, the operation of the strike must be repeated at least two or three times over the entire area.

11. The attempt to secure a hard surface is often made at the sacrifice of a true crown, the tendency being to rub the material out until the surface is flat.

Conclusions to be drawn from the abuses of the hand striking and floating method lead in most cases to faults due to the very wet mix used and to the element of human labor. If these conclusions are correct, then why should we refuse to believe that any other method of performing this work, after the two faults mentioned have been removed, is likewise improper? From careful observation I have drawn the following conclusions on the advantages to be secured by use of a mechanical means of finishing and striking the concrete:

CURB MADE WITH WELL-ALIGNED, RIGIDLY-HELD FORMS.

1. It is entirely unnecessary to use a wet mix; in fact, a more dry mix is very advisable. This will greatly increase the ultimate strength of the concrete.

2. It is not necessary to increase the water content to our roads in 30-ft. sections between the joints and the total, allow

sufficient time for striking and floating. Instead of waiting for the finishers to catch up, the machine is waiting for more concrete. We have only been able to lay 600 linear ft. of roadway per day, and consequently do not know what the real capacity for work of the machine would be. However, it is safe to place this figure at from 900 to 1,000 ft. per day.

3. Waves in the surface are dispensed with. The strike moves transversely and leaves just enough excess concrete for compression to the final grade. The compression pan is placed at a slight angle to permit a more uniform and gradual compression on the concrete. The material under the pan at all sections receives the vibrated compression for a period of about one minute, and more if desired. After the pan has passed any section there are three noticeable features apparent at once, (a) none of the coarse aggregate is exposed at the surface; (b) there are no collections of water on the surface; (c) just enough excess mortar has been brought to the surface to provide a smooth, strong, impervious covering. The surface is left in an ideal condition for the finishing float which follows. After the completion of the float's work, the appearance of the surface is self-evidence of the completeness of the task. Not a wave in the surface, a perfect crown across the entire width and no exposed aggregate.

4. Compare the cost itself of striking and floating with that involved in the other method. The hand method requires at least four or five men. By the use of the machine, only one attendant is necessary, and it might be added that the only necessary qualification he must possess is a willingness to take an interest in the work. Any man who can operate a gasoline engine can operate a Baker Finishing Machine.

5. Possibility of speedy work removes the possibility of having to resort to the abuse of retempering.

6. The vibrative compressive force takes place over a wide section, and there is no flow of mortar into a section previously compressed.

7. A wet mix dispenses with tamping, but weakens the concrete. On a more dry mix the machine produces this tamping, resulting a very dense concrete, free from practically all air bubbles and seepage voids, without a separation of the mortar and aggregate.

8. It is impossible for the machine to ride the concrete, the trucks being fitted with bracket scrapers mounted ahead of the wheels to keep the rails clean. Consequently, there is no tipped effect, and the road must be down to the proper grade across the entire cross section.

9. Only one forward operation is necessary for thoro completion of the work. Machine has no reverse speeds.

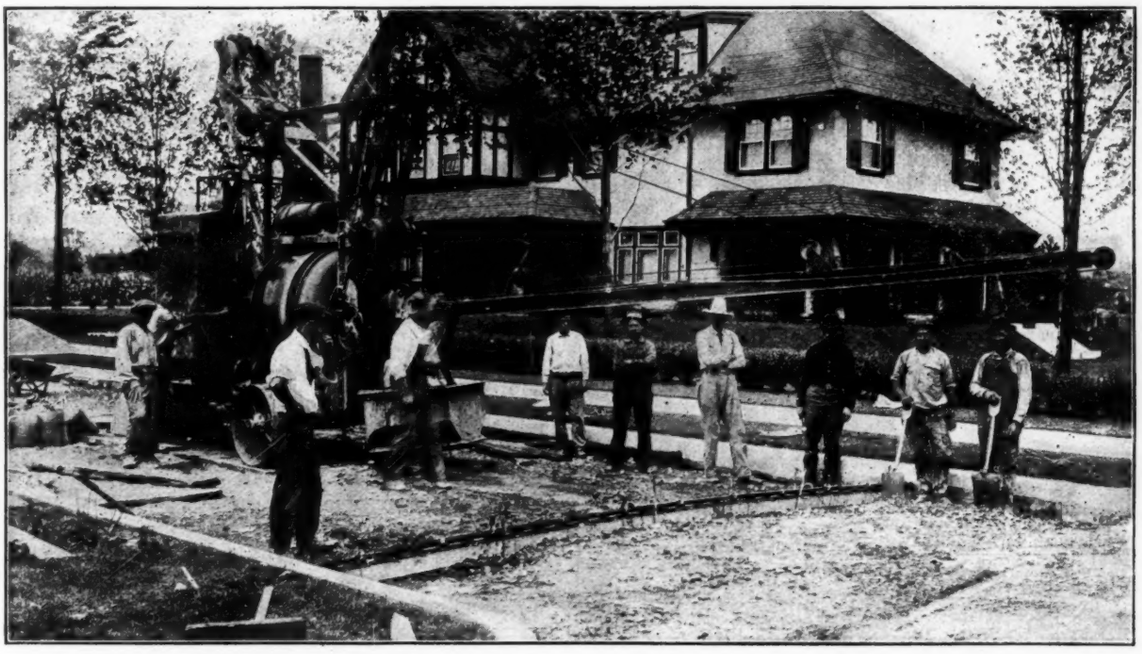
10. The vibration produced is crystalline in effect, leaving a surface that is hard, smooth, dense and impervious. The finished work is practically monolithic in structure.

11. No appreciable time elapses between striking and floating, as occurs in the old method. From the time any section has been subjected to striking until it is floated and completed but 2½ minutes have elapsed.

The Belt Finish

Finishing the surface of a concrete pavement by means of a belt drawn across the pavement with a sawlike motion, instead of by the customary methods of wooden hand floats, has given most satisfactory results in Utah. At first there was some hesitation in using this method on wide city streets. It was thought that a belt 30 ft. in width or over would be difficult to handle. Nothwithstanding this doubt, J. M. Tracey, City Engineer of Ogden, determined to experiment with the belt method on Van Buren avenue, a street then being paved with concrete, 49 ft. between gutter lines. The belt was of canvas, 51 ft. long and 12 in. wide. With the exception of lifting and removing the belt from one place to another, two men were able to handle it almost as easily and with equally as good results as on slabs of much narrower width. The process of lifting to remove the long belt was made comparatively easy by utilizing the bridge.

Levi Muir, Assistant Engineer of the Utah State Road Department, applied the same method later, using two 15-in. belts, one leather and the other canvas faced with rubber. In the beginning the leather belt was drawn over the surface, and an additional smoothness was given by drawing the rubber side of the canvas belt along the work. After numerous trials the leather belt was abandoned, and only the rubber-faced canvas one was used.



McKINLEY PLACE, GROSSE POINT, MICH. MASON L. BROWN, ENGINEER; MYERS & LABADIE, CONTRACTORS. A TWO-COURSE CONCRETE PAVEMENT, SHOWING TRUS-CON ARMOR PLATES IN POSITION READY FOR CONCRETE. THESE HAVE BEEN PROPERLY PLACED WITH THE TRUS-CON INSTALLING DEVICE, WHICH ASSURES ABSOLUTE ACCURACY

TRENCH AND TUNNEL EXCAVATION

By J. F. Springer, New York City.

(Continued from July Issue.)

The removal of material from the excavation may be accomplished by the shovel. Indeed, the shovel may frequently be used whatever the dimensions of the ditch, the hindrance to general application coming more from the crowding of cross braces rather than from the depth. If the depth is more than 8 feet, a stage may be arranged at a convenient level. Upon this platform, men in the bottom of the trench throw material. One or more men on the stage, then throw the material up to one side of the ditch or perhaps to a second stage at a higher level. A recommended arrangement is to use two men at the bottom of the excavation to throw onto the stage, one man at either end. Then one man on the stage may at times be sufficient to keep it clear. The stage may extend across the full width of the trench or not. A location of about 6 feet below the surface may often be found convenient for the stage. If the trench is quite wide, it may be found desirable to narrow the stage in order to make it possible for material dug between its ends to be thrown directly onto it. Where stages are arranged at several levels, they should be located about 6 feet apart, vertically, or even at somewhat less intervals. However, the men in the bottom can throw material up to a stage 8 feet above them. It is advised that round pointed shovels be used at the bottom of the trench and square edged ones on the stages.

Material On One Side.

The bulk of the excavated material should be placed on one side of trench and on one side only. However, if traffic conditions permit, it will often be found desirable perhaps to separate the turf or paving removed at the time of opening up the trench and pile it by itself on the side not used to receive the bulk of the excavated material.

Excavated material may often be advantageously removed from the bottom of the trench by the use of grab buckets. In fact, as such buckets are often capable of securing their own load from unloosened material, they may at such times be used to dig as well as remove. With them, we get rid of platforms as the material is at once lifted the full height. The bucket may be operated by a derrick, a locomotive crane or a hoisting plant arranged on a skid. Or, a cableway may be stretched along and over the site of the ditch and the bucket operated from it. In this case, special provision will have to be made for getting the loaded bucket off to the side. Or, the bucket may be operated by a hoisting engine set up back of one of the banks and controlling a rope running over a sheave in a kind of head frame arranged over the trench opening. This head frame may be made movable. Thus it may set on wheels which in turn rest on an improvised track; or the head frame may now and again be jacked up and shoved forward on rollers; or it may be arranged on runners, the forward movement being gotten by means of a winch and a rope or chain.

All the foregoing methods are such as to be applicable either by the use of ordinary tools and rigging capable of being constructed by the contractor or else by the employment of equipment in ordinary use by general contractors on other, than sewers and water main trenching. In addition to these methods, there are others whose application requires the use of specialized equipment—that is, of mechanical devices especially designed for trench excavation. I have scarcely space in this present article to do justice to these. They are to be treated separately.

Use of the Drill.

In the excavation of sewer and water main trenches, *rock* is often encountered. By rock is meant material incapable of being dealt with by ordinary methods. To follow the lines of a model specification, rock consists of boulders having a volume larger than ½ cubic yard of such solid ledge that its removal will require "drilling and blasting or wedging or sledging or barring." A boulder of ½ cubic yard size would weigh somewhere around half a ton. Accordingly, it requires blasting or else the use of handling apparatus, such as a steam shovel or a grab bucket.

Drilling will be done either by hand or by the use of a special machine. There are at least two principal types of power driven drills. The one may be styled the *percussion drill.* Its distinguishing feature is alluded to in this name. The drill itself is made to strike the rock, the advance being largely due to the impact of the moving drill. Such drills are often, not to say usually, mounted on tripods. The operation is by steam or compressed air. These machines, when mounted on tripods, require considerable room, making it difficult to drive holes close up to the walls of a trench. Their use is, accordingly, more advantageous where the trench is to be wide enough to justify the machine for the central holes. However, the percussion drill may be mounted on a *quarry bar* —that is, on a horizontal bar held in position by two pairs of weighted saw-buck legs. With this arrangement, holes may be driven fairly close up to the wall.

There is a third method of mounting—this makes use of the *mining column,* which permits, when usable, the hole to be driven at any angle or even vertically overhead. Its use will often be advantageous where the sewer or water main is to be laid in a tunneled excavation. If the excavation here is to be of small diameter, steam may prove unsuitable.

Types of Power-Driven Apparatus.

The percussion drill is sometimes operated by means of a portable electric motor and a *flexible shaft.* Still another form of percussion drill is that which is operated electrically upon the *solenoid* principle. "The drill is mounted on a tripod, and it differs very little in appearance from an ordinary air-drill. The absence of motor, rheostats, starting box, cranks, shafts, gears, cams, packed joints, close fits, stuffing boxes, and exhausts is always appreciated in coming in contact with this machine." This quotation is from Charles Prelini, an authority on excavation methods. When driving deep holes by the percussion method, it is usual to start with a hole larger than that desired and to diminish the diameter at intervals. This precaution serves to provide against the drill binding in the hole.

Another type of power-driven apparatus is the *hammer drill.* It differs fundamentally from the percussion drill in that the drill has no motion parallel to the axis of the hole. It rests, or is held, against the bottom of the hole and a blow is struck upon its other end by a power-driven ram or piston. This is a wonderfully compact machine, occupying but little more room than a crow bar. One man operates it, unless perhaps when it is used in certain difficult situations. With his right hand he grasps a handle similar to that used on a short-handled shovel and with his left takes hold of the handle of a wrench set horizontally on the drill. The compressed air, supplied by a flexible hose, enters the machine just beneath his right hand and secures the up-and-down movement of the piston or ram. A tube carries part or all of the exhaust air down to a position where it is directed so as to serve the purpose of keeping the hole clear. As the strokes are made, the operator turns the wrench in a horizontal plane, ⅛ of a

turn at a time being good practice. This serves to keep the bottom of the hole level, upon which the straightness of the hole probably largely depends. A power hammer drill capable of driving holes with a diameter of 1½ inches weighs 25 pounds. One driving a hole 2 inches in diameter weighs but 35 pounds. The hose required is quite small, having a diameter of only 7/16 or ½ inch.

In limestone (oolithic), varying in its hardness and being very irregular, a dozen drills of the smaller size produced an average record of 4 holes per drill, each hole 18 inches deep, in a shift of 10 hours. One machine drilled 36 holes, each 42 inches deep, in 7 hours. These drills seem exceedingly well-adapted for trench work. The diameters mentioned above refer to maximum sizes and not to the diminished sizes at the bottoms of deep holes. This must be borne in mind when considering the usable diameter of explosives. At the bottom of 3-foot holes made by the smaller drill, ⅞-inch powder may be used; by the larger drill, 1¼-inch powder.

The Use of Explosives.

Whatever method is used to make the holes, once the latter are drilled, it makes little or no difference. Dynamite is a favorite explosive with which to do the blasting. However, in trench work, "gunpowder, or black powder, and contractor's powder are sometimes used, especially for breaking down frozen earth, for quarrying stone, which may be readily split out and for cracking boulders and large pieces of ledge rock." The engineer or contractor must expect to use larger quantities of explosives in trench and tunnel work than in ordinary quarrying or even in surface blasting. One principal reason is that the rock is more securely held in the ledge—there is only one face with which to deal, and the rock is held in all other directions.

I have scarcely space to deal in detail with blasting. Consequently, I must confine myself to some of the principal matters. In trenches, the holes are ordinarily spaced about a yard apart, whether we look along the axis or across the trench. If the width of the trench is just 3 feet, there will ordinarily be two holes abreast, one on either side. Prof. Ogden says that he has "in soft limestone, for trenches for 6-inch pipe not over 8 feet deep, particularly when only the bottom of the trench was in rock, put down a single row of holes in the middle of the trench; but a large amount of picking and hammering is always necessary to finish up the work. In sedimentary rock in thin layers, or when a thick layer comes just above the excavation bottom, it is only necessary to drill the blast holes to the bottom of the desired trench. But in tough granites and thick, hard limestones with strata disadvantageously placed, it is frequently necessary to drill 1 foot below the trench bottom in order to have every point of the bottom at least 6 inches below the pipe."

The Stationary Compressor.

Sometimes it will be preferred to use a stationary compressor. In this case, it will be necessary to pipe the air to the point of use. Now compressed air is no exception to the general rule that we lose a percentage of energy when we transmit power. This is the case with electric current, with steam, etc. The only question that need concern us is whether the loss with compressed air is an uneconomical one, as compared with other alternatives. Let it be understood at once then that compressed air may be transmitted with small loss of pressure (tension), provided the original pressure and the pipe diameter are suitable to the case in hand. There are three principal factors governing the loss of pressure from friction in transmission. These are: (1) The initial pressure, (2) the length of the pipe line, and (3) the diameter of the pipe. Apparently, the pressure loss is proportional to the length of pipe; so that, if we can learn its amount in any given case for 100 feet, we can at once determine its amount for the whole line. The matter is, so it seems, more complicated when considered in connection with variations of initial pressure and of pipe diameter. Thus, the variation of the size of the pipe from 1 to 2 inches, 100 cubic feet of free air being the volume in question, 100 feet the length of the pipe, and 90 pounds the initial pressure, is responsible for a change in the loss from 5.19 pounds per square inch to 0.12 pound. This is a very great relative difference, even after taking into account the relative change in contacting surface. Consider another case: Let the initial pressure be 100 pounds, the length of pipe 100 feet, and the quantity of air 2,000 cubic feet. With a 4-inch pipe, the loss of pressure will be 1.13 pounds per square inch; and with an 8-inch pipe, only 0.03 pound. These examples are sufficient, perhaps, to make us alive to the *enormous advantage* of a large size pipe. Even a small increase in the pipe diameter is competent to effect a considerable reduction in the pressure loss. Thus, in the last illustration, suppose that instead of making the jump from the 4-inch pipe to the 8-inch, we simply make the very moderate increase to the 5-inch size. The loss in pressure drops from 1.13 pounds per square inch to 0.36 pound. Consider now the effect of varying the initial pressure. Let the amount of air in question be 1,000 cubic feet, the length of the line 100 feet, the diameter of the pipe 3 inches. If we have an initial pressure of 100 pounds under these conditions, the pressure loss due to friction is 1.25 pounds per square inch. If the initial pressure is 10 per cent. less—that is, 90 pounds—then the pressure loss is 1.39 pounds. We may learn from this that, other things being equal, the higher the initial pressure, the less the pressure loss. The variation in pressure loss is quite moderate. Take another case. Let the amount of air be 2,000 cubic feet, the length of line 100 feet and the pipe diameter 10 inches. For 100 pounds initial pressure, the loss is 0.01 pound per square inch for 90 pounds, it is tabulated the same—that is, 0.01 pound. Possibly there is a slight difference, too small to make a show in the tables. Take a case of a smaller quantity of air, say, 100 cubic feet. Let the pipe line be 100 feet long and the diameter 1¼ inches. Corresponding to initial pressures of 100 and 90 pounds, we have losses of 1.3 and 1.44 pounds, respectively. We learn then that the initial pressure plays a very modest part. Probably the additional cost involved in producing 100 pounds pressure instead of 90 pounds will more than offset the moderate loss of pressure, unless we have some necessity demanding the higher pressure. The thing to fix one's attention upon is the *pipe diameter*. This plays an important part. Coupled with the length of line, the total loss may be quite serious.

It has been pointed out elsewhere that the loss of pressure from friction in transmission is not so serious as one's first consideration might lead him to think. The loss in pressure is somewhat offset by the fact that we have a gain in air with which to work. A thousand cubic feet of free air is compressed so as to have a pressure of 100 pounds will have a certain volume. This volume will be less than if the same amount had been compressed so as to have a pressure of 98 pounds.

It is naturally important, however, to make sure that *at the working point* we have the pressure needed and a trifle to spare.

In constructing sewers, water mains and the like, it will at times be necessary to provide against the settlement of nearby structures. Occasionally, even structures at some distance may be affected by the excavation—as when a stratum of quicksand is released by the trench or tunnel in cases where the confinement of the sand is necessary to the stability of buildings built anywhere upon it. Even the unwatering of an excavation may adversely affect the support of buildings some little distance off. As a rule, however, it is the building close at hand that demands our attention. Our excavation may pass beneath a corner or beneath one side of a wall. That is to say, the carrying on of the excavation

operations may involve us in *underpinning* the foundations of certain buildings. I shall not take up space here in detailing old methods, but will call attention to the modern system of underpinning with the aid of a concrete pipe encased in a steel sheath. This system has been put to extensive use in New York City in connection with the new subways now under construction. William Street, for example, is occupied beneath the surface for a large part of its length by the excavation of a subway tube. Tall buildings have their foundations—or perhaps it would be better to say, the support of their foundations—more or less trespassed upon from below. Great underpinning operations have been required in this and other neighboring regions. I propose to give a brief account of a successful method used on William street.

Concrete-Steel Piles.

The concrete-steel piles are about 14 inches in diameter. The sheath consists of section after section of steel tubing of thin material. First the sheath is put down. Then it is cleaned out. The concrete is then poured into it and the pile is completed. Such piles may stand in a double row beneath the foundation of a building wall along one side of the street. Their heads will not reach quite to the foundation, a heavy mass of concrete being interposed. Let me explain how such piles may be driven and formed beneath the foundation and how the mass of concrete is put in place, despite the fact that both this and the piles must at some stage of construction be loaded with the great weight above.

One of the first things to do is to get underneath the foundation. This is done by very small sections at a time, although a wall may be undermined at several separated points simultaneously. Great care has to be taken. It may be necessary to open up even the small section a bit at a time, the excavation waiting until the bit of exposed under surface is supported. However, suppose that a pit has been dug alongside the concrete slab on which a row of footings rest. This pit may be extended cautiously beneath the slab until enough space has been gotten to accommodate a pile or two. We may then drive these piles.

The sheath is driven down by means of a hydraulic jack. First, the bottom section of tubing will be set up on the floor of the pit. This will then be driven by a jack reacting against the under surface of the concrete slab forming the ultimate foundation. It may be necessary to do more or less blocking up in order to cover the full vertical space. When one section has been forced into the soil, another is set upon it and both together as a single unit are jacked down. One section fits into another much as a spigot end fits into a bell. The procedure of lengthening the sheath is continued until the required penetration is accomplished. The cleaning out may now be done. For this purpose, at least in some situations, a diminutive orange peel grab bucket has been found suitable. This bucket may be weighted, if necessary, to give it digging power. A kind of screw or auger may be employed, where it seems more suitable. When the cleaning out has been completed, concrete is filled in. If the foot of the sheath has reached and fairly entered an impervious stratum, it may be possible perhaps to clear the tube of water. Otherwise, we may have to deposit the concrete through the water. It should upon no account be dumped in and allowed to fall through the water. Such a procedure would likely disintegrate the concrete more or less. A bottom-dump bucket may be useful. I am not aware that a tremie has been employed in this work, but there seems no reason why it should not be used, as the underwater placing of concrete by the tremie has lately reached an approved position in practice. I am referring now to the best methods. When the concrete has reached about the top of the sheath, we put in place a metal cap which covers concrete and sheath, the central portion of the cap extending an inch or so down into the sheath. The object of the downward projecting portion is to put pressure on the concrete before it comes on the sheath. The jack is rigged above the cap so as to have reaction against the foundation, as before when driving the sheath. We now force the whole pile until the resistance and behavior are satisfactory.

The jack is now carrying the load and the pile is supporting the jack. The problem that now engages attention is the relief of the jack in order to permit its removal. This problem is solved by putting two I-beams in vertical position on the cap, these beams reaching from cap to within a trifle of the foundation. Wedges are now driven in the space at the top of the beams until the load has been transferred, as perfectly as may be, to the beams. Naturally, the wedging procedure will fall somewhat short of a complete transfer of load. This will become apparent, upon the release of the jack, by a slight rise of the pile. It is considered quite important to reduce this reaction of the pile to as small an amount as possible. In fact, no reaction at all is what is wanted, in order that no disturbance of conditions at the foot of the pile may enter. So far as I am informed, however, no method has been put into use which effects a total elimination of the rebound. We will suppose now that we have put in and wedged to a satisfactory degree all the piles we propose to put in the small section of excavation beneath the foundation. We may now place suitable planks and concrete the pit beneath the slab or other ultimate foundation. This concrete will, of course, envelop and imbed in itself the I-beam uprights.

It may be necessary to unite footings above a foundation slab in order to prevent independent settlement. One method of doing this is to set short lengths of I-beams in such way as to make criss-cross work, each length reaching obliquely from one footing to the other. If these are properly set in niches cut for them and the whole concreted, we get a kind of inverted arch.

Methods of Tunneling.

Tunneling is apt to be expensive. It is nevertheless at times quite necessary and may be more economical than trenching because of the depth of overlying material. It is usual by ordinary methods to protect the excavation from cave-ins and the like by the use of timbering. Recently, however, a method has been developed and used on important work in which timbering is partially or entirely eliminated. The method is, unfortunately, not everywhere applicable. By this procedure, the excavation of the arch is closely followed by the construction of a concrete arching. As soon as the centering is removed, this arch of concrete takes care of the overhead strata without timbering and without other obstruction of the tunnel. The further prosecution of the excavation is facilitated because of the access to the heading, especially where any arch forms that may be in place are constructed forms of the sides of the excavation which afford support for the arch may or may not be cut away for the substitution of concrete side walls in the space thus left vacant. In case the exchange from rock to concrete is necessary, it will naturally be carried out piecemeal. A certain amount of timbering may be needed to sustain the arch during this procedure.

Where the tunnel passes through water bearing strata, compressed air and the shield may be employed, provided the hydrostatic head is not too great. The limitation arises, not from any inability of compressed air to exclude water, whatever the pressure behind it, but from the fact that the men doing the actual excavation—the "sand hogs"—can not live and work in an atmosphere whose pressure (tension), much exceeds 45 pounds per square inch. Where the tunnel passes beneath a river or arm of the sea, another limitation may enter. As the air in the tunnel heading presses in every direction with full force, it is necessary that the resistance overhead shall be sufficiently stable. Otherwise, the air will find a line of weak resistance and a "blow out" will occur.

Such "blow outs" have occured at New York in the subaqueous excavation of recent years. They may sometimes be successfully combatted by covering the areas of weakness with clay blankets.

Tunnels excavated with the aid of compressed air and the shield are usually lined with rings of cast iron or wood placed in position one after another to form a circular shell. The individual rings will consist of segments. The shield is advanced, from time to time, by means of jacks pressing against the exposed annular and plane surface of the last ring put in place. The "tail" of the shield, as the rear part of the cylindrical shell of metal is called which is every now and then forced ahead, envelops one or two rings. When the jacks have been withdrawn after an advance, there is a clear space in the tail where a new ring may be assembled. At Worcester, Mass., a certain amount of 6-foot sewer construction was done by shield and compressed air. *Wooden blocks* were employed for the lining.

The Lawrence Avenue Sewer at Chicago is an example of tunneling during which the shield was employed. It is not always necessary to use compressed air with the shield. Whether it is to be used or not will turn largely on the amount and pressure of the water encountered. The pressure to be used may have to be a compromise. If the full pressure necessary to keep water from entering the bottom of the excavation is used, then the pressure may be sufficient to render the operations subject to "blow outs"; if only enough pressure is used to exclude water perfectly from the extreme part of the excavation, then the bottom may become soft and the shield difficult to manage in consequence. The pneumatic method is not to be regarded as inexpensive. But it is a pretty sure procedure, when used in its proper field of activity.

Care of Drill Bits.

Of great practical importance in rock excavation are the character and care of the drill bits employed. Solid bar steel is employed in *percussive* drilling, and hollow bar in *hammer* drilling. The external outline of the cross-section may be circular, hexagonal, octagonal or cruciform. The Germans use a twisted bar on whose end a kind of Z-shaped cutting face may be formed. The cutting face of American drills usually consists of edges radiating from a center. There may be half a dozen of such edges and there may be only two. In the latter case, the two edges being 180 degrees from each other, we have simply a single cutting edge forming a diameter. If the cutting edges all lie in one plane, then we have a "square" edged bit. Such a type is suitable for use *after* the hole has been well started. For *beginning* the hole, however, a bit whose edges form a convex cutting face is understood to be very effective, the convexity biting into the rock. On the other hand, this type seems to be liable to the formation of crooked holes, if the rock is seamed, the bit seeking to follow crevices. The cutting face will occupy a larger gross area than the cross-section of the shank. This secures ease of movement.

The care of the bit is very important indeed, especially the heat treatment termed hardening and tempering. The precise temperature to which a drill bit should be heated for hardening will depend largely upon the character of the steel used. The maker of the drill rod should be able to supply accurate information upon this point, in respect to his own steel. A good deal depends, however, upon the quenching. It is understood that the common method is wrong—that ordinarily the bit is immersed to too great a depth. The outer, comparatively thin parts of the bit will cool faster than the center. The blacksmith is apt to take the bit out, so it seems to be thought, before the central part has cooled. Sometimes, the attempt will be made to harden with the heat used for forging. It is recommended that the drill bit be hardened by dipping it vertically into ¾ inch of gently flowing water. It is important that the drill be vertical, as otherwise one side will be hardened further back from the face than another. After hardening, the usual carbon steels should be tempered at the temperature suited to the circumstances. The bit should then be sharpened. In by-gone times, it was usual to do this by hand, but today it is possible to use a special machine adapted to sharpen to precise form and size. Mr. M. Gault, at one time superintendent of sewers in one of the New England cities, is reported as stating that the cost of drill sharpening had been reduced to one-third the previous cost by the use of a special machine. The work is probably much more accurately done in addition. It is understood, among other things, that the cutting edges should present right angles.

Use of Special Braces.

The special braces which have been designed are of several varieties. Some are entirely of metal; others are partly of wood. Generally, the brace is lengthened or shortened at one end only. The extending and contracting will ordinarily be accomplished by turning a threaded rod in a strut provided with an internal thread or *vice versa*. It will be possible to go along the trench and tighten or loosen the braces as circumstances may require. With the object of keeping the strut itself horizontal and at the same time providing a bearing surface more or less inclined to the vertical, ball and socket joints have been employed. Complaint has been made, it appears, of considerable breakage with such joints. It is understood that this breakage is mainly due to unevenness of fit in the joint, the convex and concave surfaces not being machined. If this objection is well founded, it ought to be possible to meet it without much difficulty or extra expense. Undoubtedly, such surface could be readily ground to form and size by a special grinding machine. The grinding would not need to be carried to any high degree of precision.

Whatever type of brace is used, lugs should be arranged at both ends to provide against the brace falling down upon the workmen in case it is accidentally loosened or in case the earth yields back of the sheeting.

Sheeting of wood or steel may often be driven by a wooden maul. Such an implement may weigh upwards of 25 pounds. The wood of the head should be held by rings or bands of steel or by an equivalent. Naturally, one sets the bands so as not to interfere with the blow. The bands should be secured firmly in place, say, by the use of wedges and pins. The handle should not be round. A hammer or pick handle is suitable.

A hammer of, say, 16 pounds weight is needed for shifting and otherwise dealing with the braces. The head may advantageously have two opposite striking faces that are perfectly flat. Altogether, the head may resemble a spool of thread—that is, it may be a cylinder with flat bases provided with ridges back of the faces. It is understood that hammer of this description is more suitable for working with braces than is the ordinary sledge.

For considerable information contained in this article the author is indebted to the Harold L. Bond Company, E. I. Du Pont de Nemours Powder Company, Wemlinger Steel Piling Company, Sullivan Machinery Company and the Ingersoll-Rand Company.

Joint Leakage in Vitrified Pipe Line

By William W. Brush, Deputy Chief Engineer, Department of Water Supply, Gas and Electricity, of New York City.

The Boro of Richmond had an inadequate and unsatisfactory water supply prior to the introduction of the Catskill water, which was made effective in January, 1917. The average daily consumption in the Boro of Richmond is twelve million gallons. To meet the growth in consumption and to lower the overdraft at existing stations, an additional supply of some six million gallons daily was planned as far back as 1910. A driven well system was to be established along what is known as Southfield Boulevard, a broad public highway running along the southeasterly side of Staten Island. The carrying out of this plan was delayed by various causes, and the new development was not completed sufficiently to be utilized until the spring of 1915.

THE department proposed to construct the entire collecting line of cast iron pipe, but owing to the short period that would probably elapse between the completion of the development and the introduction of the Catskill water, it was necessary to reduce the construction cost to a minimum. The utilization of an existing distribution main, which was not immediately required to deliver water, satisfactorily solved the problem of a collecting line for the southwesterly section. The substitution of 18-in. vitrified pipe for 16-in. cast iron pipe for the northeasterly section reduced the estimated cost for same from $27,000 to $20,000. At the time of the substitution of vitrified pipe for cast iron pipe, as recommended, Mr. I. M. deVarona, then chief engineer of the bureau, noted that a risk was taken of excessive leakage, but, based upon previous experiments, it was concluded that the joints could be made sufficiently water-tight to permit the pipe line to satisfactorily serve its purpose. There was no fear of the pipe itself being of insufficient strength to withstand the pressure, which was estimated at a maximum, under working conditions, of about 5 lbs. per square inch.

The pipe was to be laid to grade on the bottom of the trench, except where the earth would not properly support the pipe, when either timber or concrete supports were to be furnished.

The cold weather interfered with the work, as did also the water in the trench, due to the ground water level being above the pipe invert between the main station and station No. 3. The contractor selected for the joint compound an asphaltic mixture known as "Filtite A," which was the material previously used in tests made by the bureau and which had been successfully used in sewer work in Brooklyn.

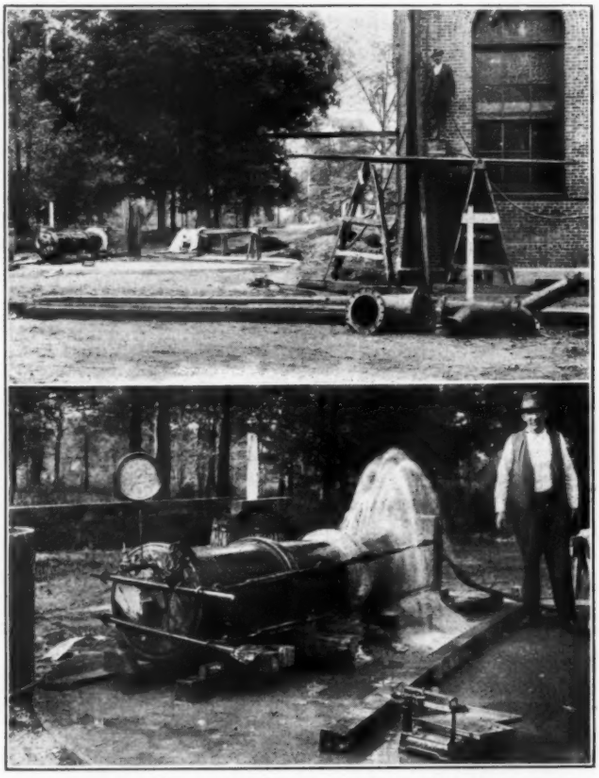
Leakage at Joints

When the laying of the pipe had been completed, the infiltration of ground water was noticed. The flow was gaged at the central pump well in the latter part of February, and early in March, and found to average during a three-day test 43,470 gals. per 24 hours. This was equivalent to 163 gals. per joint per 24 hours. The seepage indicated that some leaks would be found.

On April 7 this line was placed under test, the head being about the working head, and at 22 points between stations 54-13 and stations 66-74, a distance of 1,261 ft., water showed on the surface. Here the boulevard is a fill over a swamp and the foundation for the pipe is consequently somewhat unstable. When the leaky joints were examined the conditions disclosed might be described under these three heads:

First—Where a separation existed between the joint compound and the barrel of the pipe or between the joint compound and the hub. This separation varied from the merest hair-line opening to an amount which would admit the passage of a knife blade.

Second—Where the joint compound had started to blow out, in general more at the bottom of the pipe than at the top, varying from the merest indication of starting to cases where pieces of the compound were ready to fall out.



TESTING PIPE JOINT COMPOUND WITH HYDROSTATIC PRESSURE. LOWER VIEW SHOWS PIPE WHICH BURST UNDER 40 POUNDS PRESSURE.

Third—Where the joint at the bottom was entirely blown out. In some cases the pieces of joint material were thrown out by the laborers in excavating, and in one or two cases I found pieces of the compound in the mud upon searching around with my hands. It is quite evident that this joint compound does not adhere to the glazed surface of the pipe under service conditions. While a thin film of the compound, when poured over a very clean place on the pipe, seems to adhere, a considerable thickness of the material, as in the case of the joint, does not.

Contractor Made Repairs

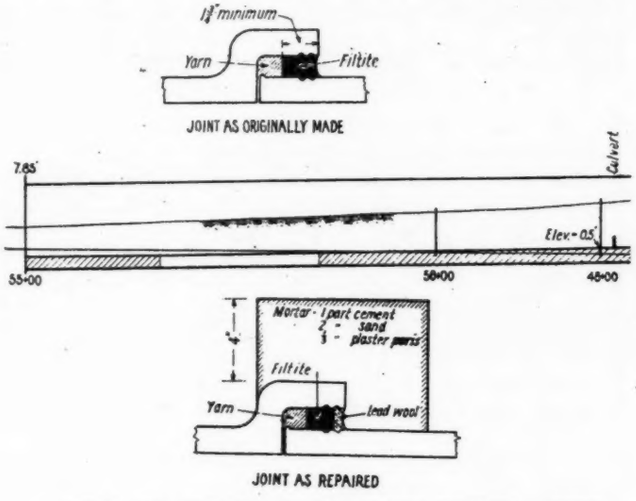
On April 14 the contractor had re-run the leaking joints, and on April 15 the pipe was again subjected to test by operating both pumps in Station 4 (the most easterly one). Fifteen leaks developed on this test. After a discussion as to the responsibility of the contractor to repair all leaks, under a clause which required a year's guarantee of all the work, he

made the repairs, beginning June 4, finding 58 joints to be replaced.

Leaks have continued on this line since then up to the shutting down of the plant in February, the record being as follows:

	1915	1916	1917
January	..	19	4
February	..	26	6
March	..	36	..
April	..	10	..
May	..	11	..
June	End of maintenance period by contractor		
July	11	19	..
August	4	36	..
September	4	66	..
October	3	29	..
November	8	6	..
December	..	24	..

The contractor made all his repairs by removing the joint material and re-running the joint. The department men tried various schemes, the most successful being to drive the joint material into the hub, caulk in lead wool, and then place a concrete block around the joint. The repaired joints, in general, did not leak again. Practicall yno trouble was occasioned by split pipe, only one or two being found in the whole line.



TEST OF VITRIFIED PIPE AND JOINTS. PIPE BURST AT PRESSURE OF 40 POUNDS PER SQUARE INCH.

Experimental Tests of Joints

In 1912 the bureau had tested 12-in. vitrified sewer pipe, using the "G. K." compound and "Jointite," which is the predecessor to "Filtite" and practically the same material. This test showed the joint would stand 29 lbs. per square inch. At the same time joints made of plain yarn, with yarn soaked in cement grout and with lead wool, gave very unsatisfactory results. At an earlier date cement joints poured also leaked freely.

After the leaks were discovered, two tests were made, one in the field at Grant City and one at the Portland avenue yard in Brooklyn.

The Grant City test, which is illustrated by the photographs, was as follows:

"Three lengths of vitrified pipe were used in making the test. Pipe No. 1 was a complete hub and spigot pipe which had been condemned on account of an interior blister; spigot end inserted in joint 'A'; about 2 in. of this spigot end was not salt glazed. To the hub end of this pipe was attached the wooden outlet bulkhead.

"Pipe No. 2 was a complete hub and spigot pipe which had been condemned on account of an exterior blister. Hub end of this pipe in joint 'A' completely salt glazed; spigot end in joint 'B' and was completely salt glazed.

"Pipe No. 3 was a hub and spigot pipe, about 3 in. of the spigot end of which had been cut off on account of slight cracks; hub end of this pipe in joint 'B' and was completely salt glazed, and the spigot end was attached to the wooden inlet bulkhead.

"The pipes to be tested were set on a timber grill and rested on wooden wedges to preserve line and level. The wooden bulkheads and the iron tie rod being the same as were used in previous tests at the North Portland avenue yard, Brooklyn.

"On May 19, 1915, work was started on the physical test of the pipe and compound. Joints 'A' and 'B' were caulked with grout-soaked yarn, after which the joint space was thoroly cleaned and dried; the joints were then run with joint compound taken from a new barrel marked 'A-3,' a sample of which was sent to the laboratory on May 18, 1915.

"On May 22, 1915, joint runners were removed from joints at 9 a. m.; joints were carefully examined and found to be good.

"At 10:30 a. m. started filling test pipes with water, air valve open, head 4 ft. Pipes full at 11:05 a. m. and air valve closed at 12:05 p. m.

12:40 p. m. No leakage; head increased to 8 ft.
1:10 p. m. No leakage; head increased to 9 ft.
1:47 p. m. No leakage; head increased to 10 ft.
2:20 p. m. No leakage; head increased to 11 ft.
2:55 p. m. No leakage; head increased to 12 ft.
3:15 p. m. Test suspended due to rain; pressure removed and air valve opened."

The pressure of 12 ft. was again put on May 26 and continued without leakage until May 27, when both joints were leaking. The leakage reduced from a maximum rate for each joint of about 24 gallons per 24 hours to about 10 gallons for one joint and 2 gallons for the other, the test continuing until June 14, when the pressure was slowly raised to 35 lbs., and held there for 35 minutes, with a leakage from one joint of 232 gallons per 24 hours. The pressure was then raised to 40 lbs., when a pipe split.

Description of Test

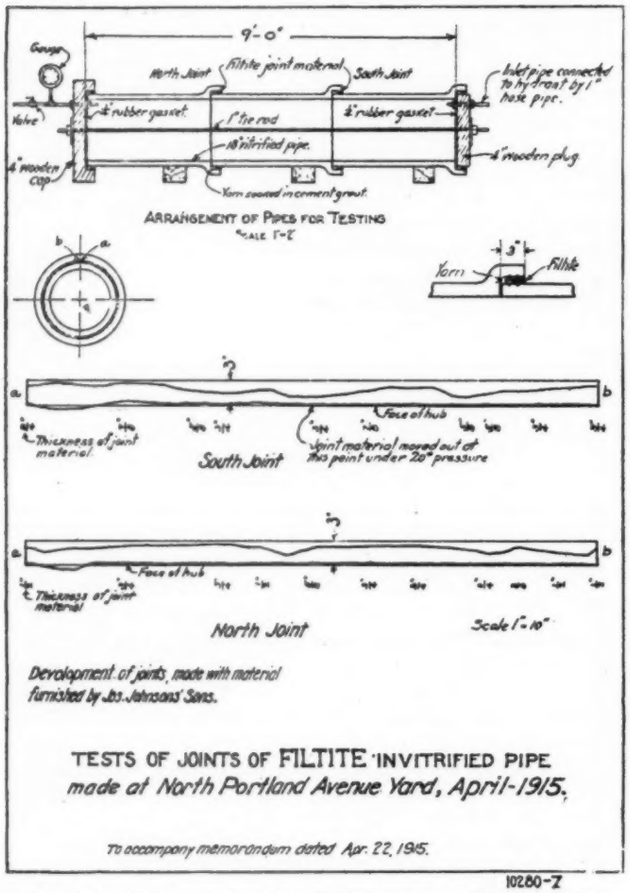
The description of the test at the Portland avenue yard is as follows:

"On account of the failure of a number of joints in the vitrified pipe collecting main in Southfield Boulevard, arrangements were made to set up and test vitrified pipes having joints of the material used in Southfield Boulevard, or material similar thereto. Two test lines, each consisting of three lengths of 18-in. standard deep and wide socket vitrified pipes, with bulkheads at the ends, were set up at the North Portland avenue yard. The arrangement of these test lines is shown on the accompanying print, No. 10,280-Z.

"The joints of one of the test lines were poured with material received from Joseph Johnson's Sons, the contractors for the Southfield Boulevard job, and the test records of this line are shown on Sheet No. 10,279-Z. The joints of the other lines were poured with similar material furnished by the Pacific Flush Tank Company, who furnished to the contractor the material used in Southfield Boulevard.

"The joints were made in accordance with the specifications, a jute gasket dipped into cement grout being used at the back of the joint. The material received from the Pacific Flush Tank Company was first poured. Before pouring, the cement remaining on the surface of the southerly of the two joints in this line was brushed off the pipe, so as to leave the pipe clean. The cement was allowed to remain on the surface of the pipe and spigot of the north joint. It was attempted, as specified for the Southfield Boulevard contract, to pour the

material thru a gate located a little to one side of the top of the pipe, allowing the joint material to flow down and around the pipe and up on the other side. On the joints where the Pacific Flush Tank Company's material was used this was not accomplished, the material flowing both ways from the top of the pipe. On the north joint the clay gasket used to confine the joint material broke thru several times during pouring and



ARRANGEMENT OF JOINT TEST AND DEVELOPMENT OF JOINT MATERIAL.

the time necessarily elapsed between successive pourings while the clay was being repaired. The south joint was provided with a rubber hose gasket and no difficulty from breaking out of the material was encountered.

"On the line in which the contractor's joint material was used, hose was used as a gasket and the joints were poured, as specified, the material flowing from one side only.

On April 21 tests were made of pipes joined with the Flush Tank Company's material, and also that furnished by the contractor. In a 25-minute test of the compound furnished by the former, the initial pressure was 5 pounds, this being gradually increased to 20 pounds. Leakage was serious even at 10 pounds pressure. Caulking was attempted, but was found to have little or no effect in stopping the leakage. Practically the same test was carried out on the pipes joined with material supplied by the contractor. Leakage was less but results were far from satisfactory. Results of this test are shown in a table reproduced on this page.

"The pipe in which the contractors' joint material was used age, the south joint moved out at the bottom, so that no further was then broken and the joints removed for examination. It was found that the south joint, which failed, was deficient in depth at the bottom. The yarn gasket had apparently not been driven back into the socket sufficiently to permit the full depth of the joint to be poured. The remaining joint appeared to be satisfactory.

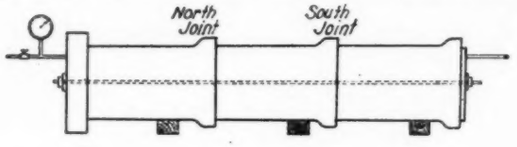
"The north joint in the line, in which the flush tank company's material was used, was then cut out with a cold chisel. This joint was, of course, known to be defective on account of the trouble during pouring. It was found that hollow spaces existed in the joint material.

"There seems, however, to have been no lack of adhesion to the joint, except where the joint had been caulked so that the joint material was broken."

Conclusions

The experimental work and the field results showed that the vitrified pipe would safely stand low pressures, say under 25 lbs. per square inch, that none of the joint compounds were successful in preventing leakage, but that fairly satisfactory results could be obtained by thoroly cleaning the joints before running them. The use of cement-soaked yarn appeared to be detrimental in its effect on water-tightness of the poured joint.

TESTS OF JOINTS OF 'FILTITE' IN VITRIFIED PIPE
made at North Portland Avenue Yard, April-21, 1915.



II Joint material furnished by Jos. Johnson's Sons.

TIME	PRESSURE # PER □"	LEAKAGE IN GALS PER DAY		LOCATION OF LEAKS	
		No JOINT	So JOINT	NORTH JOINT	SOUTH JOINT
9:00	0# Pipe Full	Slight Leakage			None
10:27	0# Pipe Full	Slight Leakage	Slight Leakage		
10:35	5#	180	135		
10:39	10#	270	270		
10:45	15#	360	630		
10:50	20#				
10:52	20#		Joint moved out		moved out here

To accompany memorandum dated Apr. 22, 1915.

10279-Z

DATA FROM JOINT TEST ON VITRIFIED PIPE.

The bureau has during the past month been experimenting with caulked cement joints for cast iron pipe, following the instructions given by Mr. Clark H. Shaw, in his paper presented on April 18, 1917, before the American Society of Civil Engineers. These joints have been highly successful under test pressures up to 300 lbs. per square inch. There seems to be no good reason why a caulked cement joint in a vitrified pipe would not be water-tight up to the pressure the pipe would safely stand if care is exercised to caulk only to an amount that the hubs will stand without cracking. Experiments along this line are to be undertaken by the bureau in the near future.

Pavement Problems on New York Bridges

A study of the causes underlying excessive depreciation of pavements on the Queensboro, Williamsburg and Brooklyn bridges, with outline of new paving methods involving use of shallow wood block. From data prepared by Edward A. Byrne, acting chief engineer, Department of Plant and Structures, New York City.

EXCESSIVE vehicular traffic over the more important bridges that span the North river resulted in pavement wear that some time ago made necessary an entire replacement of the roadways. In each case the pavement was redesigned to avoid the weaknesses that had developed with the old methods, when the traffic became too heavy. An exact count made at each of the four principal bridges showed that from 18,304 vehicles in 1912, the number had in 1916 increased to 35,034. Of the 1912 total, 11,893 were horse-drawn and 6,411 motor-driven. In 1916 11,584 were horse-drawn, while the motor-driven vehicles had increased to 23,450, an increase of nearly 300 per cent. in the motor vehicles, while the number of horse-drawn wagons remained practically the same.

Study of Queensboro Bridge

On account of the bad condition of the paving at the Queensboro bridge and the detrimental effect that this hindrance to traffic had on the development of the boro of Queens, this bridge was the first to receive consideration. Funds for the work were provided early in 1916, and in November of that year one-half of the roadway—the southerly half—had been reconstructed and opened to traffic.

The pavement (old type) of the Queensboro bridge consists generally of treated wood blocks on a Portland cement-concrete foundation. This foundation rests on different bases at various sections of the structure. On one approach the base is of reinforced concrete, which in turn supports water-proofing protected by common brick, on which the pavement foundation is laid with a thickness of 6 in. On part of the other approach the concrete foundation, 6 in. thick, rests on earth fill and part on buckle-plate floor. On the main bridge buckle plates ⅜ in. thick support the concrete foundation. Main dimensions are as follows:

Length of the approach on reinforced concrete.1,052 ft.
Length of the approach on earth fill..... 436 ft. 2½ in.
Length of the approach on buckle plates.....2,236 ft.
Length of the main bridge on buckle plates....3,724 ft. 6 in.

Total length of bridge.....7,448 ft. 8½ in.

The width of the roadway is 52 ft. 3 in., which means an area of 43,240 sq. yds. of wood block pavement to be maintained. The pavement laid on reinforced concrete and on earth fill, amounting to 8,640 yds., has not required any repair from the time the roadway was opened to traffic on March 30, 1909. The part laid on buckle plates, 34,600 sq. yds., has been a source of constant trouble during the past 4½ years.

The design of the roadway floor where buckle plates are used called for the placing of these plates on stringers having a top flange width of 12 in., spaced 5 ft. on centers, the plates being laid with the buckle down. On this floor a Portland cement concrete base (1:3:6) was laid. The depth of this foundation, for the greater part of the roadway, varied from 1½ to 4½ in. On this concrete a cushion of very dry cement and sand mortar ½ in. in depth was spread and the blocks were laid at right angles to the center line of the bridge with ⅛ in. joints.

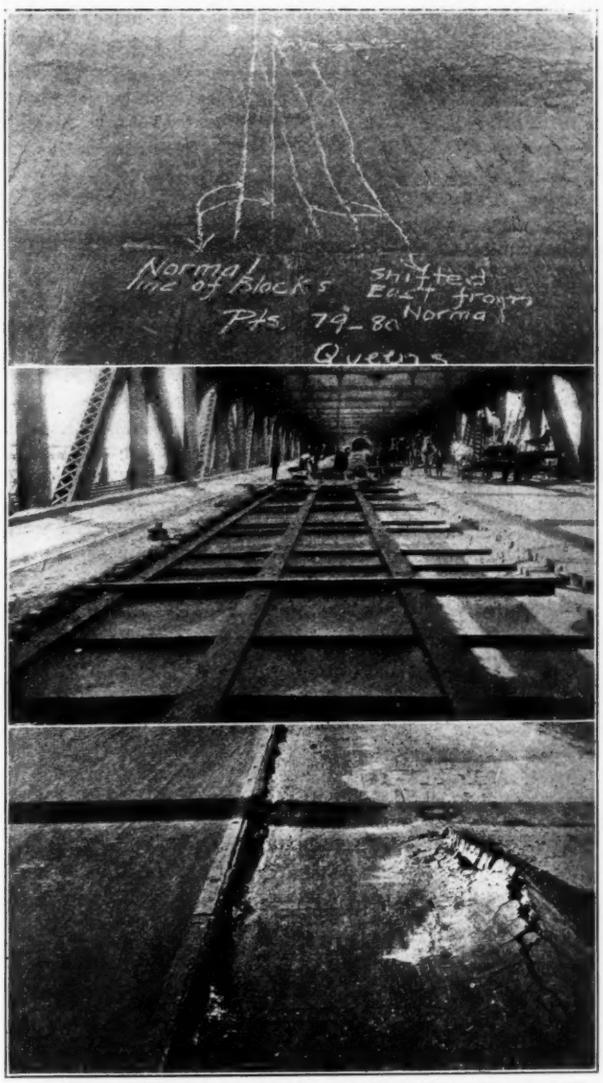
The blocks were 4 in. in depth and cut from sound, long-leaf yellow pine planks 4 in. thick and from 7 to 9 in. wide.

The blocks were treated by the creo-resinate process, and the usual tests were specified.

The joints were filled with paving cement of a bituminous material, free from coal tar or its products.

Poor Drainage Caused Buckling

The Queensboro bridge was opened to traffic in March, 1909, and for the first two years of service this pavement required but slight attention, but the constantly increasing traffic commenced to affect the foundation quite seriously. The buckle plates, under the heavy traffic, continually deflecting, caused the concrete to crack and disintegrate at many points. As the stringers provided a more rigid base, the concrete over them stood up much better.



VIEWS SHOWING PAVING OF QUEENSBORO BRIDGE: 1. OLD BLOCKS SHIFTED 12 INCHES OUT OF LINE; 2. LAYING NEW BLOCKS ON COMPOSITE FOUNDATION; 3. NEW AND OLD WORK SIDE BY SIDE. (BULGE IN OLD PAVEMENT IS 14 INCHES HIGH.)

The concrete used was of very lean proportions for use un-

der such conditions, and it might be justly stated as a further cause why this pavement failed. The sand and cement cushion has also been a source of trouble. This cushion, for lack of ability to drain, is always damp, and after storms it is thoroly saturated. When these storms are followed by rapid changes in temperature, the blocks commence to heave, and this heaving in many places has amounted to over 3 ft. above the normal surface of the pavement. This cushion provides a shifting base for the blocks, and this, together with the expansion and contraction of the bridge, further accelerates the movement of the pavement. At some points the cushion has entirely left its position at the buckle plate and moved to a point over the stringers, and, in doing so, has raised the blocks above the concrete foundation. On one or two occasions vehicular traffic over the bridge had to be confined to the spaces occupied by the trolley tracks to avoid possible accident. There are two trolley tracks laid on this bridge within the pavement limits, each located near the curbs.

New Blocks Without Cushion

A new foundation has been designed by the author, which in general consists essentially of a parquet foundation, formed by a combination of timber planking and Portland cement concrete, with the creosoted wood blocks laid directly on this foundation, without a cushion.

The timber used was long-leaf yellow pine, merchantable inspection, dressed to thickness varying from 2½ to 4½ in. in depth on the main spans, with a width of 14 in., and on approach span from 3 to 3½ in. in depth, with a width of 12 in. These planks were laid flat and bolted to each line of stringers by machine bolts spaced 27 in. apart. The planks were given two coats of preservative mixture, applied by brush method. The heads of the bolts were finished flush with the top of the plank and the countersunk hole around the head was filled with Portland cement mortar. The space between the planks was filled with a Portland cement concrete (1:2:4), the top of which was finished smooth at the top of the plank.

On this composite foundation creosoted wood blocks were laid, with a sand joint, and, as stated before, without a cushion. These blocks are 3 in. in depth and cut from 3x8-in. long-leaf yellow pine timber.

Buckle Plates Reinforced

The buckle plates have been reinforced by riveting 3x3x⅜-in. angles to the unsupported fillet of the plate. On the main bridge these angles are riveted to the under side of the plate, and on the approach span, on account of the structural details, they are placed on the upper side of the plate.

The holes in the inverts of the plates are utilized for draining any water that may reach the under side of the wood blocks. This drainage has been provided by forming a hole in the concrete foundation over the holes in the invert of the buckle plate.

To assist the drainage, grooves ¼ in. deep and 1¼ in. wide have been molded in the top of the concrete, which help to lead the water to the drain holes.

The longitudinal movement of the pavement has been checked by the installation of transverse "Z" bars at alternate floor beams, forming longitudinal panels varying from 41 to 80 ft. in length. The tops of these bars are flush with top of the pavement.

Pavement Weight Decreased

In determining the design of the new pavement the department had before it the fact that there would be approximately 780 lbs. per linear foot of bridge added in rails, ties, guards, signal system, etc., for elevated train operation. It was quite important that this added load should be neutralized, if possible. After considerable investigation a design was perfected that really accomplished it.

In this design the weight of timber per linear foot was considerably increased, but this was more than compensated for by a considerable decrease in other items, so that the net result of the new design showed a decrease of from 3,750.2 lbs. per ft. in the old river span to 2,966.9 lbs. per ft. in the new—a difference of 783.3 lbs. per ft. In the land spans the decrease was 782.8 lbs. per linear ft.

It will be observed that the weight per linear foot on the river and land spans has been decreased proportionately. This was necessary on account of the fact that the department did not desire to change in any way the relative equilibrium of these spans.

The entire work of relaying the pavement, strengthening the buckle plate floor and reconstructing the curb is being done by departmental labor, the materials required being purchased by contract or open-market order.

In contracting for the wood blocks—1,600,000 3x3x8-in. blocks, 16-lb. treatment—proposals were requested on three specifications, differing in so far as the kind of oil to be used, namely, coal-gas tar, "Light;" coal-gas tar oil, "Heavy," and water-gas tar oil. The lowest bid per 1,000 blocks for each class was $27.36 for light oil, $25.90 for heavy oil, and $24.84 for water-gas oil. Four bidders submitted proposals on each specification. The contract was awarded on the heavy-oil specification at $25.90 per thousand, or $1.39 per square yard.

To measure the deflections, under traffic, of the buckle plates, a gauge was made for the purpose and set at various points on the under side of the fillets of the buckle plates. The gauge was left in position for a period of from three to five days, and deflections up to 9/16 in. were noted. After the stiffening angles had been installed similar observation were taken, but no deflections were found on these plates.

Williamsburg Bridge

The Williamsburg bridge was opened to vehicular traffic in December, 1903. It has two roadways, each 19 ft. 11 in. in width. The main bridge is 2,793 ft. in length from anchorage to anchorage, and the two approaches have a combined length of 4,515 ft., making a total length of bridge of 7,308 ft., which means an area of 32,480 sq. yds. of pavement to be maintained.

The approaches are paved with Medina (N. Y.) sandstone blocks, on a Portland cement concrete foundation (1:2½:4½). This foundation varies in depth according to the different bases on which it rests. On the earth fill it is 6 in. in thickness, on buckle plates (with buckles up) it varies from 4 to 7 in., and on the corrugated trough plates from 3¼ to 12 in.

Old Pavement Too Soft

This pavement, of which there are 20,065 sq. yds., has worn very rapidly. The Medina block is a very soft stone, and the blocks at and near the curb have shown a reduction in depth of 4 in., due to wear. The specifications for these blocks required a thickness of not less than 4 in. nor more than 5 in., a depth of not less than 6 in. nor more than 6¼ in., and a length of from 7 to 12 in. The pavement was laid with Portland cement grouted joints.

Funds were available for the repavement of two approaches. Granite blocks, 5 in. in depth, laid with asphaltic cement joints, will replace the sandstone blocks.

The main bridge is paved with creo-resinate long-leaf yellow pine blocks, 4 in. in depth, and cut from 4x8-in. planks. These blocks are laid at right angles to the center line of the bridge and rest on 12-in., 20.5-lb. channels, having an average length of 20 ft., laid longitudinally with the bridge, with a space of ½ in. between channels, the web being horizontal and the flanges turned down. These flanges rest directly on 7-in. channels laid transversely on 30-in. centers. The tops of the 12-in. channels were given a coat of hot asphaltic cement, and the blocks were laid on this cement with close joints, filled with an asphaltic and coal-tar compound. In 1909 these channels commenced to show signs of failure, the webs under the heavily increasing traffic deflected badly, and in many cases

this continued deflection caused fracture, necessitating the replacement of many of these channels.

Economy in Shallow Blocks

The plan proposed by the author seemed to offer a minimum of inconvenience to the traveling public, as well as being economical. This plan consisted of laying a timber floor on top of the channels and the use of a shallow wood block.

The design consists of laying long-leaf yellow pine plank, dressed on sides and edges to a uniform size of 2½x9¾ in., on the channel floor, from curb to curb in one length, and bolted to the channels by two ½-in. bolts at every alternate channel. The plank was treated by brush method, and before the blocks were laid the top surface was coated with paving pitch. The roadway was divided by transverse angles into equal sections 20 ft. in length. In these spaces were laid creosoted wood blocks 2¼ in. deep, cut from 2x6-in. plank. The wood blocks are of long-leaf yellow pine, purchased on the same specifications as those used at Queensboro bridge.

There are about 1,500 sq. yds. of this shallow block pavement in place.

This is the first bridge where blocks 2¼ in. in depth have been used. They are standing up well under the traffic. It proved to the author that if the wood underdeck is securely bolted to the supporting structure, the shallow paving block can be safely used. Its use means a saving in original cost of block of about 17 per cent. as compared with cost of a 3-in. block.

Brooklyn Bridge

The Brooklyn bridge has two roadways, each 16 ft. 9 in. wide, and a trolley track is laid on each of them near the inner curb. This arrangement, when considered with the width of the roadway, means the passing of but a single line of vehicles near the outer curb. This concentration of traffic tends to wear out the pavement very rapidly.

The main bridge is 3,455 ft. 6 in. in length and the two approaches 2,560 ft. 6 in. in length, a total length of 6,016 ft.

The pavement of the main bridge consists of 2½x10-in. spruce plank, laid transversely on 3½-in. to 5-in. creosoted yellow pine timber, laid longitudinally. This underflooring is carried on steel cross-beams. The planking on the up grade averages four months' wear, while that on the down grade averages six months, and that on the part near the center, which is nearly level, averages eight months, which means the renewal of planking twice during the year—a very costly item of expense. Several experiments have been made, and it was finally decided that creosoted yellow pine blocks, 2¼ in. in depth, cut from 2x6-in. plank, on an untreated yellow pine underdeck, would meet all requirements. There are now 150 lin. ft. of similar pavement in place on the north roadway of the bridge.

Present Plan Outlined

The plan provided for the replacement of the trolley rail, which is of a tee section, by a groove girder rail. The tee-rail is not suitable for use in a roadway of this type. It affords very poor facility for the turning in and out of vehicular traffic from track area to roadway area; it is expensive to maintain on account of its inadequate supports, and it is laid to a grade of 1¼ in. above the grade of the roadway. The laying of the girder rail will mean the correction of these defects.

The new design of roadway floor will add 100 lbs. per linear foot of bridge for both roadways, two-thirds of which will be carried by outer cables and one-third by inner cables. The present dead load per linear foot of bridge is 8,000 lbs.—4,480 lbs. on inner cables and 3,520 lbs. on outer cables.

The increase in dead load is more than offset by the fact that the present rough spruce planked pavement will be replaced by a smooth wood block pavement.

New Type of Concrete Bridge

A special type of concrete bridge has been devised to meet the requirements of the arid regions of our southwestern states. These bridges extend across the beds of streams which are dry or nearly dry the major part of the year, but are on some occasions extremely high.

Must Meet Conditions

Practically all creeks and smaller rivers in the district where the new bridge is used are dry eleven months out of the year, and in the remaining one month carry an excess of water for not more than a day or two at a time. A stream will suddenly change its character from a mere trickle or a dry bed to a torrent 10 to 20 ft. deep, returning to its original state in 24 hours. Only in extreme cases does the flood period extend over one or two days.

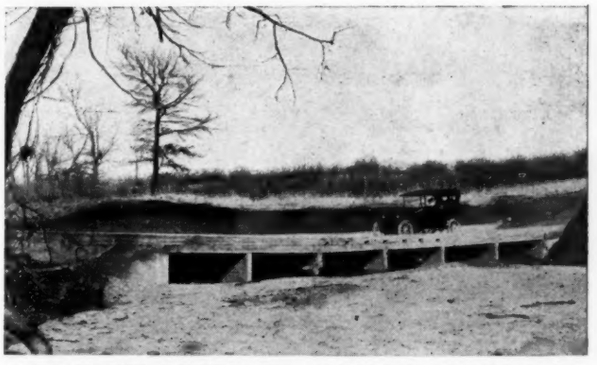
Such a condition makes a high bridge, in which $2,000 to $5,000 has been invested, comparatively useless during the greater part of its life, and, as little money is available for roads and bridges in these regions, economy must be practiced. Moreover, because of the large amount of debris carried by flood water, the floor of an ordinary highway bridge must be above the flood level, which fact necessitates approaches with wing walls and abutments.

Economy has forced engineers to design a bridge of the type here illustrated, which gives service most of the time without too large an expenditure. This is generally known as a "low-water bridge."

The "Low-Water Bridge"

A low-water bridge in its commonest form consists of several short reinforced concrete spans which clear the ordinary dry or low-water flow. These spans are carried on piers, which rest either on footings, if a rock bed is available, or on a concrete slab when the foundation is sand or gravel. In the latter case an apron or cut-off wall extends into the stream bed to protect the slab from scour.

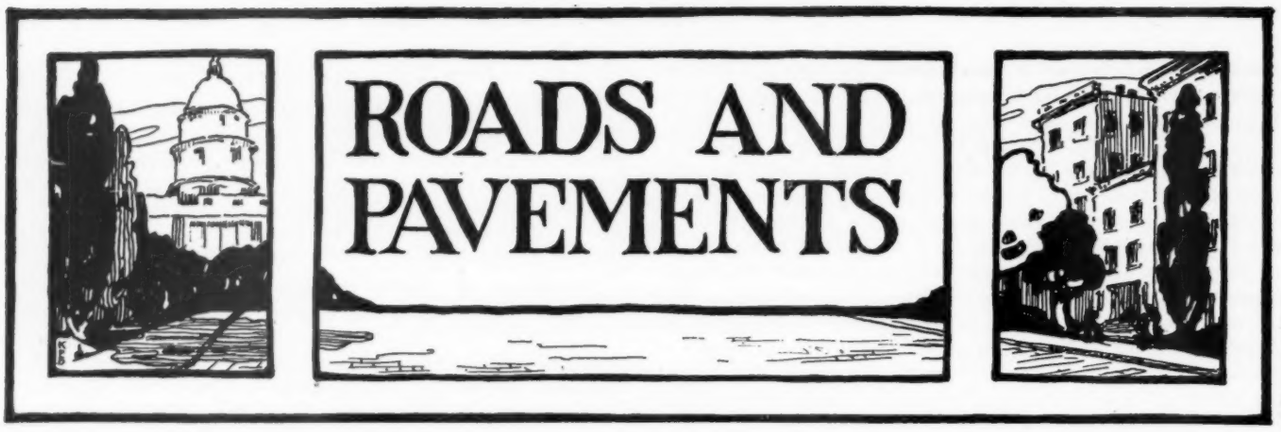
In the bridge illustrated by the accompanying photograph the piers rest on a slab 60 ft. long placed in the bed of the stream.



LOW WATER REINFORCED CONCRETE BRIDGE OVER SANDY CREEK, PONTOTOC COUNTY, OKLAHOMA.

During the high water these bridges are wholly submerged, therefore guard rails or hand rails are omitted to prevent the lodgment of detritus or suspended matter. In many cases the center of a bridge is lower than the ends.

To the dweller in a flat, well-watered country a low-water bridge is rather incomprehensible because of the fact that his native rivers remain in flood for weeks at a time. This is not the case in the Southwest, for during a hard rain few people care to travel, and the average stream becomes a mere creek a few hours later.



Block Paving in New Form

A form of block paving that has for many years been widely used in Europe is now finding quite general favor in certain American cities. The granite blocks as used in this form of street improvement are much smaller than those seen in the ordinary cube block pavement, being cut in the form of 3½-in., or, at most, 4-in., cubes. These blocks, instead of being placed in straight rows, are arranged in a pattern of concentric interlocking circles. Claim is made that such a pavement, properly laid, is practically as smooth as asphalt and easily cleaned.

On account of the small size of block as generally used in this "oyster shell" pattern paving, an excellent foothold for horses is provided.

THIS TYPE OF GRANITE BLOCK PAVEMENT IS LAID IN CONCENTRIC ROWS, CALLED THE "OYSTER - SHELL" PATTERN.

(Courtesy Popular Science Monthly.)

As none of the courses run straight across the street, the load is much more evenly distributed and the shock that comes when two wheels of a heavily loaded wagon strike a course at the same instant is materially lessened.

The Brooklyn-Brighton viaduct, Cleveland, O., was recently paved with small granite blocks laid in the "oyster shell" pattern, on a substantial concrete base, and furnishes a typical example as to methods used in installation. The blocks on this job were laid on a cushion of dry sand and cement, the section laid each day being thoroly wet down at night. A mixture of equal parts of sand and cement brushed into joints between the blocks united the whole into a monolithic mass.

Costs as given on this work were $2.50 per square yard for labor, cushion, blocks and grout.

Care in Details Lowers Roadbuilding Costs

By Leslie H. Morris, Cupertino, Cal.

The first requisite of a good concrete pavement is a sound subgrade, and the basic quality of a sound subgrade is a uniform texture of its components. To secure satisfactory and acceptable results at the lowest cost, this last point must be kept constantly in mind, no effort being spared to reach as near perfection in each step of the work as is possible. Any lack of uniformity will result in shrinkage, which will require rerolling—or, if this is neglected, it will manifest itself as a crack in the finished pavement, and injure the reputation of the builder.

In the destruction of the existing roadway a type of scarifier should be selected with which a uniform depth of disturbance may be maintained. This is best affected by adjusting the teeth to the inequalities of grade by means of levers fulcrumed on a wheel-carried frame. The market offers a range of this type of machine varying from extreme lightness to a combination grader and scarifier representing extreme stability. But irrespective of type, the work should proceed in a manner that will destroy the maximum of large lumps and clods. An orchard disk will be found very useful for completing the work.

Use of Water in Making Fills

In making fills the best results have been attained by limiting layers to one foot in thickness, by a liberal use of water, by spreading going and returning teams over the entire width, and by rolling. For fills of two feet to six feet diking and flooding is employed, seepage to undisturbed ground being thereby secured. For depths greater than six feet, a winter's rainfall is necessary to secure a complete settlement.

A string stretched between nails driven in opposite grade stakes will enable a skillful operator to grade within ¾ in. of the bottom edge of the header boards. Each header zone and the foot outside should then be wet and rolled in order that the stakes to which the header boards are nailed may be properly supported. The header boards act as forms for the concrete, mark the finished surface of the paving, and are guideways for the proper elevation of subgrade. It is therefore important that they be carefully set and maintained to true grade by nailing them to 16-in. stakes set about 7 feet apart.

Making a True Surface

Before using the shaper-templet, the area inclosed by the headers should be as completely pulverized as possible, and reduced to a uniform texture by sprinkling lightly and harrowing until mealiness is effected. This will assist in securing a true surface. In using the shaper-templet it is essential that each end shall be constantly in contact with the header boards, and that its shoe shall conform closely to the required curve of the finished subgrade.

When the subgrade has been properly harrowed and brought to the desired contour, it should be watered suf-

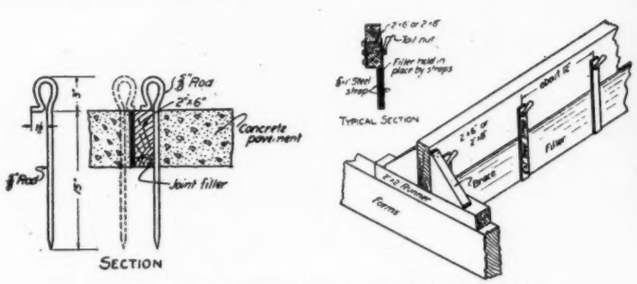
ficiently to insure that the moisture will penetrate to the undisturbed soil. Unless this is attained no bond will be established. Uniformity of sprinkling is necessary, and the best results are secured by a double application. As a preparation for rolling, a light harrowing, as a slight crust is forming, is excellent. Its tendency is to furnish pulverize the subgrade and reduce any non-homogeneous elements or inequalities of moisture. Experience is the best indication of the precise moment to begin harrowing. At least a ten-ton roller should be used as soon as the subgrade has dried sufficiently so that it will not "pick up" or "wave." Twice over will usually produce an unyielding surface, which may be made still harder and sealed by sprinkling for a few days. Once sealed maintenance must be kept up by sprinkling at intervals of a few days, depending on the weather, until the surface is covered with concrete.

Time Work According to Weather Reports

A low subgrade may be traced occasionally to a variation in the coefficient of compression of the soil. This is best remedied by thoroly scarifying to a minimum depth, after which more earth is thrown on and the shaper-templet, adjusted for the estimated shrinkage, dragged over. Rain for a week or ten days is a feature of most California paving jobs. The tendency of the beating and soaking is to make a subgrade still harder. It is excellent policy to roll all sections that are ready when advance information of rain is received from the Weather Bureau.

Installing Premolded Expansion Joints

A simple method of placing premolded sandwich type expansion joints involving the use of specially made steel stakes has been devised by an Iowa contractor. The accompanying drawing shows the form of this stake. In setting a joint by the new method a line is stretched at the desired location and a 2x6-in. header is staked to it. This header is held down by a row of pins set so that the lugs bear on the upper edge. The filler is held in place by another set of pins, as indicated in the diagram at the left.



TWO METHODS OF PLACING PREMOLDED JOINTS.

When the concrete work has extended about a foot beyond the joint, the pins holding the header are taken out and the header removed. The pins holding the joint are left until the header space has been filled with concrete.

Another method which does without pins involves the use of a 2x6-in. plank set on runners arranged to ride on the side forms. This bridge is fitted with iron straps placed about 1 ft. apart, each strap being provided with a tail nut. The filler is gripped firmly between the straps when these nuts are drawn up. This arrangement, shown in the diagram at the right, has the advantage of being entirely self-contained and without loose parts.

Creosoted Wood-Stave Pipe Line

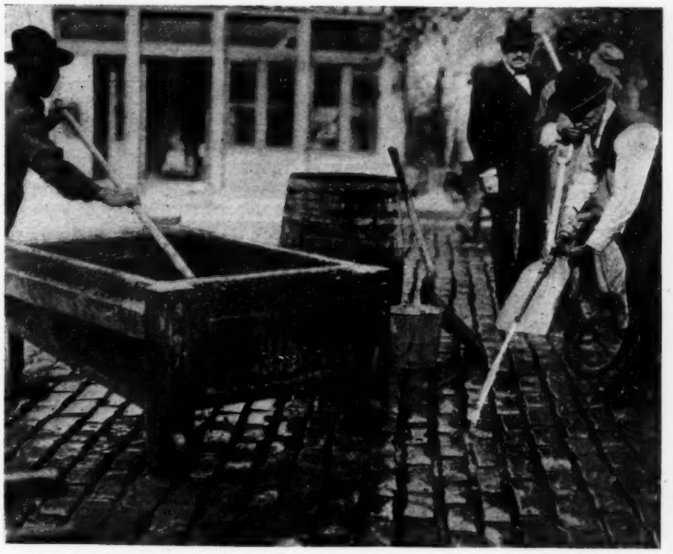
Water is now supplied to the Wenatchee reclamation district thru a 63-in. creosoted wood pipe line recently laid. This is one of a very few lines of this type laid, tho the use of creosoted wood here has numerous advantages, chief among which is the fact that the staves are non-swelling, and hence can be clinched tight when the line is put down. Tests showed that no creosote taste was present in the water carried by the treated pipe.

The City of Non-Skid Streets

Cincinnati, a city which possesses many miles of worn-out granite block pavement, in a condition highly discouraging to the use of automobiles, has, according to the *Scientific American*, discovered a way of renovating its thorofares at very slight expense. Indeed, the made-over paving possesses the great advantage of being practically skid-proof, at the same time affording proper footing for horses, even when the ordinary pavement is unsafe.

The only new material required by this process is a small amount of cement and sand. The old granite blocks are taken up and thoroly cleaned of all adhering fillers. The worn-out sand bed is removed and wherever necessary the cement foundation is repaired. A new sand bed is laid, using old and new sand indiscriminately, and the blocks are then relaid with about ½ in. space between them.

The relaid paving next receives a thoro flushing with hose, and while it is still wet a mixture of two parts sand to one of cement, with enough water to make it flow readily, is raked



RE-LAYING BLOCK PAVEMENT IN CINCINNATI STREET.

and swept into all the interstices. Before this filler dries a finishing coat of sand and cement in equal proportion is spread evenly over the entire surface of the pavement. This surfacing coat makes the street as smooth as newly laid asphalt; and the longer it stands, the harder it gets. Four days are allowed for firm setting before the street is opened to traffic.

Experience is that the cement grouting never chips from the granite, but actually becomes better with continued traffic. It affords a non-slippery surface in winter and in wet weather alike. The smoothest tire will hardly skid on it, and, unlike brick and wood block paving, it does not cause horses to slip.

Streets which were resurfaced five years ago are in as good condition to-day as when just completed. As fast as the granite pavements need repairing they are being resurfaced by this method, until Cincinnati is fast becoming the city of non-skid streets.

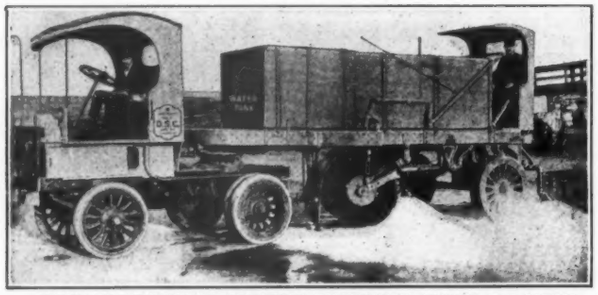
Maintaining Road Shoulders

During 1916 the New York highway department maintained over 6,000 miles of roads. This work was under the direction of Fred W. Sarr, second deputy commissioner, who gives in his report for the year the length of each type of road maintained and the cost of the work per mile. During recent years there has been some question whether it is fair to the different classes of road surfaces to include in the cost of maintaining them the cost of maintaining the shoulder on each side of the surfaced roadway, as is done in the New York figures. It has been claimed that the maintenance of the shoulders is affected by many local conditions, such as slope, rainfall, traffic and width of surfaced roadway, and that the cost of maintaining the shoulders should therefore be kept distinct from the cost of maintaining the roadway. Mr. Sarr takes the contrary view for the following reasons: "In view of the fact that the traffic is not confined to the pavement by curbs and the earth shoulders are a part of the traveled roadway, the cost of the maintenance of the pavement has not been separated from that of the shoulders. This method would seem more consistent for the purposes of comparison, for the reason that the cost of maintenance of the shoulders of those pavements, having a general low cost, is much higher than for maintaining the shoulders of those pavements which have a general high cost."

Gas-Electric Sweeper and Flusher Cleans New York Streets

In New York City the problem of efficient street cleaning has been solved by a specially built combination sweeper and flusher. While the prime mover is a gasoline engine, all of the power is converted to electricity before it is divided up among the different jobs.

Acting as an all-around power plant, the gas engine supplies current to a motor, which furnishes driving power to



HIGH PRESSURE STREET FLUSHER USED BY NEW YORK CITY'S STREET DEPT.

the truck wheels. Another motor turns the broom, another the flushing pump, and still another the atomizing pump. All of the auxiliary motors are controlled by the man in the rear, who gives all his attention to the cleaning operations.

It is claimed that this machine can clean between 100,000 and 125,000 square yards of paving per day and can thoroly cover a strip 15-ft. wide. Moving at a speed of 9½ miles per hour, which is well within its capacity, it could easily take care of 50 miles of street in a 10-hour shift.

The tank of this novel flusher has a capacity of 1,675 gal.

Road Improvements Badly Needed

At a recent convention of the Ohio Good Roads convention especial stress was laid on the necessity of better roads as an aid in helping the farmer mobilize his resources in the cause of humanity. Delegates from the farms did not ask to have the roads improved for them, they promised their full proportion of financial support for their construction. Different conditions are reported from New England, New York and New Jersey. There the congestion of railway traffic makes the highways of great value in delivering manufactured materials from one city to another and the motor truck has become a real necessity in meeting the urgent requirements for transporting the products of the cities.

Both of these cases show that the rational improvement of roads is an essential element of the grave economic problem of the day, to make the valuable products of the farm and shop available to the user at the lowest possible cost. This subject should be studied at once as an economic problem, the same as the provision of railway and waterway transportation, the increase in cultivated acreage and the improvement of manufacturing facilities. Crops that cannot be moved from the farms except at enormous expense are of little value to a nation which needs them now.

National Military Highways

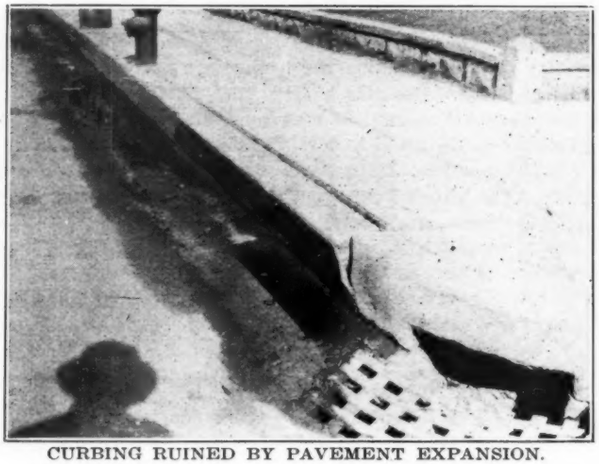
A bill providing for the construction and maintenance of a "belt highway" along the borders and seaboards of the United States was recently introduced in the United States Senate by Chairman Geo. E. Chamberlain, of the committee on naval affairs. According to the plans set forth in Mr. Chamberlain's bill, the highway is to extend the full length of the Atlantic seaboard, thence west skirting the Mexican border and northward along the Pacific coast. While the section paralleling the Canadian border line is not to be built at the same time as the other stretches, it is provided for, and will, according to terms of the measure, be built at a later date, should the bill pass.

Provision is also made for a supplementary plan of main radial roads intersecting the military marginal highway "at points and of locations and routes calculated to best serve military requirements." These radial highways are to be such as "have heretofore been constructed by the states, or as may hereafter be constructed by them independently or with Federal aid."

Pavement Expansion Cracks Curb

Lack of expansion joints in concrete work has been the cause of a quite general sidewalk and curb trouble in the city of Florence, S. C. At several points the expansion of pavement and walk has pushed the gutter back under the curb; at other places the curb has been pushed back as shown in the accompanying photograph.

Most of the sidewalks in Florence were built in 1907 and remained practically intact for five years. At the end of this period the city streets were paved with bitulithic laid on a 4-in. concrete base. This had neither longitudinal nor transverse expansion joints. When the expanding concrete met with rigid resistance, the cracking described was inevitable.



CURBING RUINED BY PAVEMENT EXPANSION.

Water and Light Methods and Suggestions

By Paul W. Doerr, Assistant Superintendent, Water and Light Department, City of Lincoln, Neb.

The receipts of the city water and lighting departments of the city of Lincoln, Neb., are regularly verified by comparing each entry on the cash book with the duplicate of the receipt issued to the consumer at the time payment was made. These duplicate receipts are filed with the city clerk and auditor, are correctly entered up, and the proper amounts turned over to the city treasurer. The treasurer's receipts must agree with all entries made of the same, and vouchers are kept on file for several "refunds" made to correct "misreadings," "duplicate payments" and "refunds on tenants' deposits." Monthly reports covering the work of both departments are made and filed with the city auditor.

Cash Register Accounting

The cash register (specially built by the National Cash Register Company for the use of these two departments) is kept in constant use. This registers separately the receipts of each department, stamps the consumers' receipts and the duplicate with a consecutive number, and adds all receipts and indicates the total for the day. At the close of business the city auditor calls and takes off the last number of receipt and the total of the collections and charges the department with this amount. At the end of the month the department's figures must agree with these figures kept by the auditor, and so, in turn, must the payments to the city treasurer.

The receipts of the water department total $163,962.09, as against $148,876.56 the year before. The lighting department collected from all sources $20,537.34, compared with $10,885.17 during the prior year. From our schedules it is noted that these departments have turned over to the city treasurer the funds collected several times during each month, sometimes as many as three times during one day. This kept the liability of these departments low, the greatest amount at any one time being $5,558.46, on April 11, 1916.

WATER WORKS ACCOUNT

Cost of water works to August 31, 1915	$1,065,728.45
Additions from Aug. 30, 1915, to Aug. 31, 1916	69,335.60
Total cost to Aug. 31, 1916	$1,135,064.05

THREE-TON ELECTRIC TRAVELING CRANE.

Amount of water pumped during the year, less slippage, 1,304,325,200 gals.

Water furnished to city annually, and for which the department receives no pay:

853 hydrants, at $45 each per year	$ 38,385.00
Water used in all city buildings, public libraries, flushing sewers, and for all other public purposes, 443,502,290 gals., at 15c per thousand gallons, would amount to	66,525.34
	$104,910.34
	Gallons
66 per cent. of total pumpage accounted for	860,822,910
34 per cent. of total pumpage furnished free to city	443,502,290
Total amount of water pumped	1,304,325,200

Using the 1,304,325,200 gals. as a basis and $59,899.34 the total cost of operation, the cost per 1,000 gals. will be .0454, but it must be considered the water department receives only a revenue on 860,822,910 gals., and the 443,502,290 gals. are furnished free to the city in general and paid for indirectly by the water consumers. Taking this into consideration, the cost of distribution is .069 per 1,000 gals.

The per capita consumption of water, using 55,000 population as a basis, is 65 gals. per day. Average daily consumption is 3,573,493 gals.

The following table shows the number of meters in use, the size and kind:

	⅜ in.	⅝ in.	¾ in.	1 in.	1½ in.	2 in.	3 in.	4 in.	6 in.	Elevator Counters
Crown	4	9378	108	91	21	24	15	11	3	..
Hersey	.	498	41	8	..	1	2	1	.	..
Gem	.	....	...	..	..	..	1	1	.	..
Trident	.	5	1	..	..	..	..	..	.	..
Worthington	.	2	...	..	..	..	..	1	.	..
Union	.	....	...	..	..	..	..	..	1	..
Elevator counters	.	....	...	..	..	..	..	..	.	2
Thompson	.	5	...	..	..	..	..	..	.	..
Davey	.	....	1	..	..	..	..	..	.	..
Nash	.	....	1	..	..	..	..	..	.	..
Total, each size.	4	9888	152	99	21	25	18	14	4	2

Total number of meters of various sizes and makes in use to August 31, 1916, 10,225.

Installation of Service Pipes

Just inside the basement wall of the dwelling, or building, into which the service pipe extends, a stop and waste cock should be conveniently located and arranged so that the water may be drawn back and all the pipes within the dwelling, or building, emptied thru said stop and waste by opening the faucets at the highest points therein and allowing the air to enter said pipes. All of the pipes connected with the service inside the dwelling, or building, should be laid with an inclination toward the point in the cellar where the stop and waste are located, without any sags or pockets, so that the pipes may thoroly empty themselves from water when said waste is opened. But in cases where such sags or traps are unavoidable, an additional stop and waster should be put in.

The service pipes in the dwelling or building should be located in the parts thereof best protected from frost, and should in no case be carried any considerable distance along side walls, but should be carried immediately under the bottom of the basement or cellar to the center or least exposed point therein, previous to being carried upward into the inhabited parts of the dwelling or building. No water supply should be laid in the same trench with lateral sewer. A record of the locations and sizes of all service pipes laid during the year, together with all necessary data, has been kept, so that, in case the boxes are covered up, they can be readily located from accurate measurements recorded.

Charge for Fire Hydrant Service

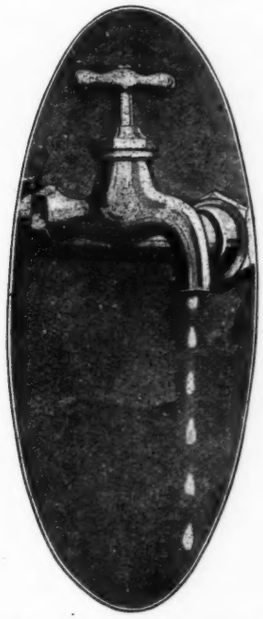
It is evident to the thoughtful investigator that the cost of

BOTTOM OF SUCTION PIPE ON THREE MILLION CENTRIFUGAL PUMP.

full fire hydrant service or public fire protection, as well as other forms of public water service, should be borne by the taxpayers of the entire community within its radius of ready-to-serve and not alone by the water rate payers; for, otherwise, the non-resident taxpayer and the non-rate payer avoid some charge of their public duty. In other words, why should not a charge be made to the city as a corporation for the hydrants, such charges to be collected from the general taxes and credited to the operations of the water works?

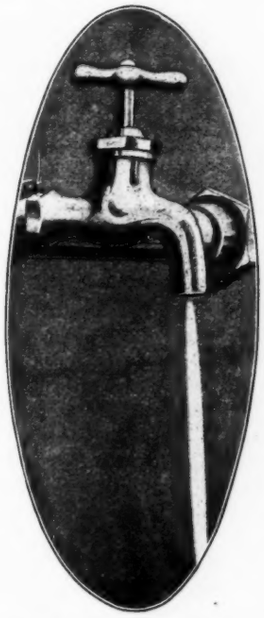
The Public Service Commission of Wisconsin is charging the municipality for whatever water is used, no matter for what purpose; and, in doing so, they give credit for the reduction by a reduction in the private rate of the people, which is a very satisfactory method of procedure.

Hydrant service is no part of the service of furnishing water for domestic purposes, and the latter should not pay for the former.



WATER JUST DROPPING.

15 gal. per day
105 gal. per week
5,460 gal. per year
Cost per day...$0.003
Cost per week. .01575
Cost per year.. .819



WATER LEAKING THROUGH 1/32 OF AN INCH APERTURE.

264 gal. per day
1,848 gal. per week
96,096 gal. per year
Cost per day.....$0.039
Cost per week.... .27
Cost per year....24.024

If the correct principle was applied water rates would be lower, altho tax rates might be higher, but the taxpayer and the rate payer would be paying for the service received upon a fair and equitable basis.

Meter All Fire Lines

All connections for private fire protection should be metered. The property owner who installs a system for fire protection on his property makes a very substantial profit from the large reduction in his insurance rates, and we do not believe that it is the duty of the city to furnish that protection by supplying the necessary water pressure unless it is done in such a manner as to absolutely protect the city from the possibility of water being drawn thru the pipes for purposes other than fire protection.

Edson Recording Pressure Gages

Edson recording pressure gages with charts are used in the office and station, showing the exact variations in pressure in steam and water, both day and night, giving the time and duration of all changes, also an additional gage showing the water pressure in pounds per square inch and the feet head. The department could not afford to be without the continuous and indisputable information supplied by these instruments. They compel safe, intelligent and efficient operation.

The Uniform Electric Rate

Assuming in all cases that rates for electricity must be based on cost of service plus an equitable fixed charge, which includes all expense incurred solely on account of the customer's installation, which are:

1. First cost of watt-hour meter.
2. Meter reading, billing, bill delivery and bookkeeping.
3. Meter installation, removal, maintenance and testing.
4. Customer's repairs, including household devices.

WATER LEAKING THROUGH 1/6 OF AN INCH APERTURE.

835 gal. per day
5,845 gal. per week
303,940 gal. per year
Cost per day.....$0.125
Cost per week... .876
Cost per year....45.591

WATER LEAKING THROUGH 3/8 OF AN INCH APERTURE.

39,657 gal. per day
277,599 gal. per week
14,474,805 gal. per year
Cost per day....$ 5.94
Cost per week.. 41.58
Cost per year...2,168.10

5. Cost of service connection from pole to building.
6. Maintenance of service connection.
7. Renewing fuses and other general office expense, such as printing, cost of fuses, etc.

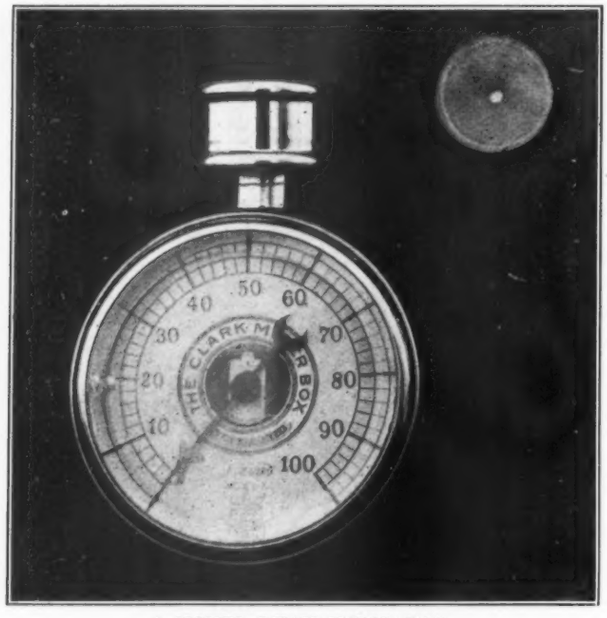
In a good many other cities a guaranteed charge per month for each horse-power or fraction thereof for power apparatus has been made. In Lincoln this has been done away with since the municipal plant has been selling current.

The municipal lighting department is growing rapidly without any special bond issue, and we believe the majority of the people of this city would rather have us be conservative and get a solid foundation instead of being overtaxed with a large bond issue.

A very interesting analysis of elements entering into cost of service is given by Percival Robert Moses, E. E., whom we quote in the following:

Manufacture of Electricity

A difference in electric pressure (voltage) is created by revolving a set of copper wires between magnets, and an electric flow (current) occurs between places when the places are connected together by a conductor, and a lower electric pressure (voltage) exists at the one place than at the other. The quantity of current (amperes) which will flow depends solely on the amount of difference in electric pressure at the two places and the resistance of the conductor to the flow. This resistance corresponds to the friction in water pipes, and, with copper conductors, increases as the length increases and decreases in proportion to the increase of area (diameter) of the conductor. Hence a wire twice as long as another of the same area will have twice the resistance, and one with twice the area, but of equal length, will have one-half the resistance.



A NOVEL LEAK INDICATOR.

Made as Needed

Electricity must, generally speaking, be made as it is needed. The use of a high-tension feeder system makes the location of the main station practically independent of location of consumers.

The size of a connection from the wire network to the customer, known as the service connection, will depend on how much current will have to be supplied at any one time, and, if there is only one customer for the one service connection, the size of his meter will depend on the same condition. If, however, as in an apartment house, there are many customers for one service, the service connection will still depend on the demand of the group as a group, but each customer will have a meter depending upon his individual maximum requirement. A station supplying a residence district will not make its maximum demand on the central station until two hours after the business district makes theirs. Therefore, there is no justification for any difference in rates charged for residence use and in the rates charged for business purposes.

It appears, therefore, that there is no difference in the operating cost of the large and the small consumer, if each pays his fixed charge.

Novel Leak Indicator

For use in detecting leaks in underground pipes an ingenious leak indicator and a very sensitive sonophone have been developed by the water works officials at Mattoon, Ill.

The leak indicator is a simple pocket-size pressure gauge designed to withstand the water hammer to which it is necessarily subjected in service. Connection of the universal type is used, so that the indicator may instantly be attached either to a hydrant, sill cock or bibb.

As used at Mattoon the sonophone is a simple adaptation of a watch-case telephone receiver, a jointed rod leading from the receiver diaphragm to the pipe. Any leak in the vicinity of the test is indicated by the sound as heard in the receiver. Any such sound is transmitted from the leak itself thru the pipe, and then is carried thru the jointed rod to the metal diaphragm of the watch-case receiver. Claim is made that this inexpensive piece of equipment enables the user to detect very small leaks. This extreme sensitiveness is in part due to the fact that the rod is free from mechanical contact with any part of the device except the diaphragm to which it is fastened.

Water Purification in Panama

Residents in the Canal Zone are now supplied with pure, aerated water treated in plants of which any large city might justly be proud. The three plants, located at Miraflores, Mt. Hope and Agua Clara, are all in direct charge of Geo. C. Bunker, physiologist for the Canal Zone.

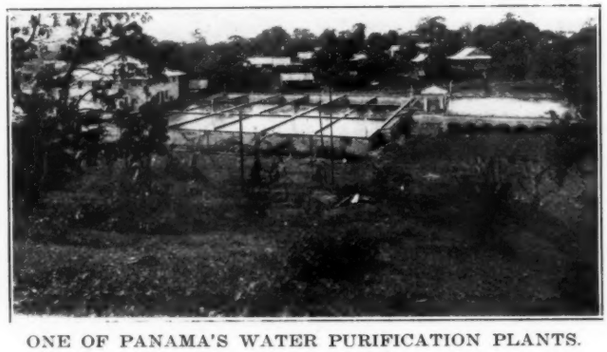
The Agua Clara Plant

From the Agua Clara purification plant filtered water is supplied to the Gatun district and Toro Point. This purification plant is of concrete construction and includes a mixing chamber, sedimentation basin, rapid sand filters and a clear-water basin. Raw water and alum solution are thoroly mixed in the concrete mixing chamber by means of a series of vertical baffles. In size the chamber itself measures 5 ft. x 30½ ft.

A 350,000-gal. sedimentation basin at the Agua Clara plant measures 70½x71 ft. in plan and is 10½ ft. deep. This is separated into two equal divisions, each of these divisions being further subdivided by a baffle wall. From the basins the settled water enters a receiving box, passing from there to the filters.

Four sand gravity filters make up the rapid sand filtration plant. These measure 17 ft. square each in plan, and are 9 ft. deep, being arranged in two rows of two units each. Each unit has a sand area of 279 sq. ft. and will filter 646,000 gal. of water per hour when operated at capacity.

Each of the four filters is provided with a layer 24 in. in thickness of graded Chagres river sand and 30 in. of Chame Beach sand. An underdrainage system of the Harrisburg type is used. Four-inch air pipes are tapped into the manifolds. In washing the filters air is applied for five minutes and the water at the rate of 3,800 gal. per minute. Wash water is carried away by two concrete troughs.



ONE OF PANAMA'S WATER PURIFICATION PLANTS.

Installation at Mount Hope

In the aeration basin at the Mount Hope plant, which sup-

plies water to Mount Hope, Colon, Cristobal and Margarita Point, five batteries of 17-cone nozzles each discharge the raw water at an angle of 30 degrees. This water takes the form of a thin sheet and breaks up into very fine drops. After aeration the raw water is thoroly mixed with the alum solution in three mixing chambers, all provided with baffles.

Special interest is attached to the sedimentation basins of the Mount Hope plant. Here the alum-treated water flows into three cross-connected basins, the total capacity of which is 2,500,000 gal. Each basin measures 171 ft. in length and one-third that width. Depth at floor valleys is 13 ft. 6 in. and at the summits 12 ft. 3 in. Two pressure walls separate each of the basins into three compartments, connected only by rectangular openings below water level. Between the pressure walls are also light baffle walls.

Each of the six concrete sand filters at this plant has a capacity of 1,226,000 gal. per 24 hours. Sand area per unit is 513 sq. ft. As in the Agua Clara plant, the Harrisburg underdrainage system is used.

Maintenance of Motor-Driven Deep-Well Pumps

By Melvin L. Enger, Assistant Professor of Mechanics and Hydraulics, University of Illinois

There seems to be very little published information concerning the cost of operation of deep-well pumps. The following notes, altho not as complete as might be wished, may therefore be of value.

	—Well Number—				
	1	2	3	4	5
Date drilled	1900	1907	1904	1905	1914
Depth, feet (about)	138	140	142	140	140
Diameter, inches	8	8	8	12	12
Cost of well, casing and screen	$559	$546	$699	$1348	$891
Cost, motor and pump	$375	$813	$788	$758	$810
Capacity, g.p.m., 1914 tests	60	69	81	71	75
Speed, r.p.m.	31	33	28	30	30

The following table gives the cost of labor and material required to keep these wells in operation for a period of sixteen months:

During the period included in the table the wells were in operation as follows: No. 1, 44 per cent.; No. 2, 34 per cent.; No. 3, 70 per cent.; No. 4, 86 per cent.; and No. 5, 89 per cent. of the total time. Taking the average, the wells were in operation 65 per cent. of the total time, or 15.6 hours per day.

The pumps had been in use for periods ranging from one to eleven years, hence the results should represent the average performance of the pumps during their useful life fairly well. The principal cause of trouble is the fine sand getting into the well and into the pump. Rods, couplings, working barrel and packing are worn quite rapidly. The conditions under which the pumps work are decidedly poor, which accounts for the high cost of maintenance.

The total cost of maintenance for the five pumps during the sixteen months was $1,008. This is equivalent to a cost of $151 per year for one pump operating 15.6 hours per day. Put in another way, it is equivalent to a maintenance charge of 82 cents per 1,000 gal. pumped.

	No. 1		No. 2		No. 3		No. 4		No. 5	
	Labor	Mat'l	Labor	Mat'l	Labor	Mat'l	Labor	Mat'l	Labor	Mat'l
October	$11.11	$0.00	$14.15	$1.21	$9.11	$0.00	$15.03	$5.90	$3.43	$1.00
1914—										
November	2.60	0.31	3.10	0.00	7.95	1.25	5.15	0.00	35.87	13.18
1915—										
January	1.46	0.94	5.06	0.00	1.86	0.13	42.77	0.15	10.94	6.24
March	10.96	10.10	2.26	0.00	7.71	1.52	1.96	0.39	11.70	0.37
April	3.83	80.84	4.61	0.00	8.18	0.46	5.97	3.30	3.86	1.16
May	3.40	0.19	3.59	0.00	27.17	0.27	3.97	0.31	4.38	7.52
June	5.92	0.45	7.64	0.33	10.10	0.55	6.49	0.54	7.72	9.15
July	49.19	0.64	2.36	0.00	3.23	0.79	2.57	0.14	4.30	0.35
August	3.38	0.01	4.01	0.00	3.06	0.00	3.02	0.00	14.42	0.01
October	6.11	1.64	2.27	0.36	3.80	0.94	6.74	1.09	18.88	0.79
November	6.75	0.07	0.99	0.20	9.73	1.55	0.66	0.93	4.08	16.30
1916—										
January	5.44	0.07	1.91	0.00	2.44	0.35	1.96	0.15	3.65	0.15
February	4.62	0.14	0.95	0.15	1.96	0.32	2.95	0.58	17.70	12.15
March	2.15	0.00	0.80	0.01	30.69	19.18	1.93	0.00	2.57	18.14
April	9.13	0.91	1.47	0.00	41.59	14.70	8.82	6.32	1.86	0.00
May	16.02	3.95	0.99	0.00	16.15	40.85	3.06	23.12	1.90	1.57
Totals	$172.07	$100.26	$56.51	$2.26	$202.73	$82.86	$113.05	$42.93	$147.26	$88.08

The water supply of the University of Illinois comes from five wells drilled about 140 ft. deep in the glacial drift of this region. The water-bearing stratum is about 15 ft. thick and consists of a sand containing much fine material. The water level in the wells when the pumps are not running is about 95 ft. below the surface, and, when the pumps are running, about 110 ft. below the surface.

The water is pumped from the wells by means of motor-driven Luitwieler deep-well pumps. The working barrels are 5¾ in. in diameter and the stroke is 15 in. The pump on well No. 2 is geared directly to its motor; the other pumps are belt-connected.

The following table gives information concerning the wells and pumps:

World's Largest Locomotive Jib Crane

A 500-ton locomotive jib crane recently built for installation in the Panama canal at Balboa, C. Z., is said to be the largest machine of its kind in the world. This giant crane is capable of raising, lowering or swinging a 56-ton load at its maximum working radius of 87 ft. from its center of rotation. The auxiliary hoist has a radius of 97 ft. and the whip hoist of 102 ft.

WORKERS IN THE FIELD

Cement-Iron Paving Block

The Editor of MUNICIPAL ENGINEERING:

Sir—Unusual traffic conditions prevailing on the approaches to the Brooklyn Bridge resulted in the adoption of an entirely new form of "armored" concrete paving block. Originally these approaches were paved with 8-in. granite blocks on a 2-in. sand cushion, with tar and gravel joints. Heavy cartage had worn this paving down to a point where replacement was a necessity, ruts having been cut to a depth of 3½ in. at some points.

Particularly heavy wear came on the blocks adjacent to the curbing, this resulting from a general custom of running wagon wheels against the curb, so that the friction of wheels

VIEW SHOWING WEAR OF BLOCKS ON BROOKLYN BRIDGE APPROACH. METHOD OF LAYING THE CEMENT IRON BLOCKS. THESE BLOCKS GO NEXT TO CURB.

against curb acted as a brake to prevent a too rapid downgrade travel. This wearing of the blocks was also quite irregular, producing a series of ridges and depressions which interfered with the speed of the movement of the vehicles, as well as causing severe jolting of their springs. These blocks required frequent repair, and where traffic is so concentrated these repairs have been of great annoyance to the traveling public.

Extra Cost Justified

While the cast iron block cost more than the ordinary form, the additional cost is more than justified, as these blocks are the only sort that would stand up against the wear. The iron castings used are made in the form of a hollow box or "crate," two sizes being used to permit of staggering joints. Dimensions are 5 in. deep by 4½ in. wide, lengths being 4 in. and 8 in., in the two sizes mentioned. Top faces are 1 in. thick; ends and bases are ⅝ in. square metal. Recesses are cast in the top faces to prevent too smooth a surface. The hollow space is filled with Portland cement concrete, which is thoroly set before the block is placed in position in the pavement. The 4-in. blocks average 8 lbs. in weight, and, when filled with concrete, 12¾ lbs. The 8-in. blocks average 13¾ lbs. in weight and 24 lbs. when filled with concrete. These blocks are laid in conjunction with the granite blocks, with which they bond with a lap joint of 4 in. The use of these cast iron blocks at the curb of a roadway 16 ft. in width will increase the cost of the entire paved surface about 10 per cent. over price of granite block pavement.

Granite blocks and the iron-concrete blocks are both laid in a Portland cement with a 1-in. sand cushion, an additional layer of concrete having been laid in the old foundation, so that the new blocks come up to the old grade.

EDWARD A. BYRNE, Acting Chief Engineer.

Municipal Motor Shop

To the Editor of MUNICIPAL ENGINEERING:

Sir—Thru the establishment of a municipal motor shop and the application of spare time on the part of firemen at the engine house with which the shop is connected, the board of police and fire commissioners at Grand Rapids, Mich., have made remarkable strides in the motorization of the fire department. The idea, which was inaugurated about four years ago, stands for a saving of a great deal of money to the city and has been responsible for the addition of eleven pieces of apparatus to the city's complement of thirty-six, nine of which were built complete and two converted from horse-drawn equipment. Two more are now in the process of construction.

The practicability of the plan was discussed for more than a year before any action was taken. Then it was decided that $1,500 could be spent as a trial for lathes, tools and essential parts. The outlay was nominal, and it was figured not to represent an investment, but more of a speculation. Frank G. Hill, master mechanic of the department, was given the supervision. He immediately saw an opportunity for doubling the efficiency of the plan—not only gaining the ends the commissioners had outlined, but working some good in an educatinoal and monetary way for the workmen. These he selected from the corps in the engine house, most of whom were without experience. An agreement was made which permitted the men to work all spare time, outside of time spent in answering alarms, in conducting the work of the shop. For this effort they were allowed 40 cents a day in remuneration for eight hours' work.

The first attempt made was on a combination hose and

squad wagon. The chassis was made by a Grand Rapids firm and a heavy motor was secured outside. Every other part was purchased locally, many of them being turned out in the blacksmith shop connected. The machine required six months in the building, and when completed, with expenditures for labor, it represented a total cost of $2,700. Specifications of the same piece submitted to a motor manufacturing concern called for a cost of $4,000. The saving of $1,300 was chronicled. On test the car made some excellent records and it has done daily service since. It proved the experiment, and the shop became an institution. Orders were immediately placed for two more machines of a similar type, and these were finished within the next year.

All of the work of assembling the machines is done at the shop. And besides the saving to the city and the acquiring of apparatus that would otherwise be considered too expensive for purchase, the shop has had a beneficial effect on the men. During the four years at least ten of the workmen, having become skilled on machining, went out to accept positions of excellent standing. All of the men were grateful for the opportunity to add to their monthly allowance, and the work gave them a chance to evade the lethargy that so frequently characterizes the members of a department. More than anything else, the shop has abolished idle gossip and it has been the means of destroying an inclination to factionalism, which threatened at one time to be disastrous.

Besides the work of manufacture, the shop is used for all the motor apparatus in the department as a repair point. If a machine is damaged and needs repair it is sent immediately to the foreman. All work on the new apparatus is then dropped for the repairs. Recently a hose wagon turned a corner, swerved and struck a tree. The front axle was bent, one wheel dished, the radiator smashed, the fenders torn off, and it sustained many other injuries. It was completely out of commission when towed into the shop at 10 o'clock Monday morning. Tuesday night at 6 o'clock it was turned out, in the best of condition. Aside from the rapidity of the work, the total cost of repairs, including the purchase of parts and labor, was only $39. Had the job been done in a private garage, the cost of labor alone would have been at least that much and the car would undoubtedly have been out of commission for a week.

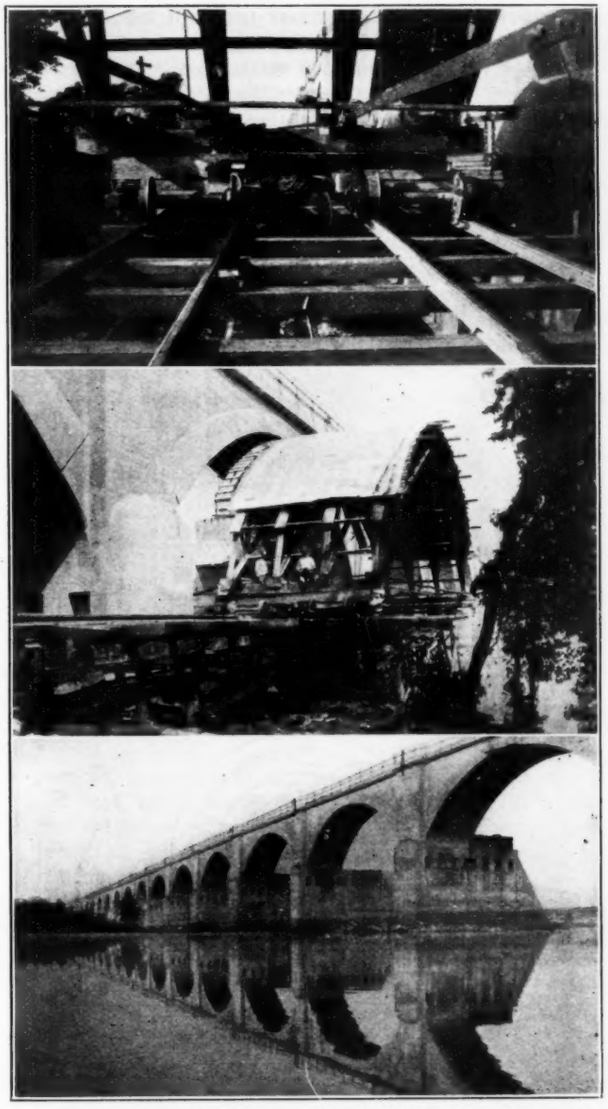
The shop, considering the original investment and the results that have been secured, is pre-eminently a success. And the idea is one that could be adopted in any small municipality where the work of securing appropriations for purchasing apparatus is difficult. It will be maintained in Grand Rapids indefinitely, and at least two pieces of apparatus will be built or converted from horse-drawn equipment every year until a point of saturation is reached. It will then be continued as an exclusive repair shop.

C. W. SHAFER,
Grand Rapids, Mich.

Economical Handling of Heavy Centers

To the Editor of MUNICIPAL ENGINEERING:

Sir—In connection with building the concrete arch viaduct across the Susquehanna river for the Cumberland Valley Railroad Company, one of the large items of expense was moving the centers. Owing to the great length of the bridge it was impossible to finish it in one season, and it was built in two halves, one half being built last year and the second half this year. As there were forty-seven arches in the bridge, this made ninety-four moves to be made. The centers were made of four steel trusses, with 4x6-in. yellow pine cut to curvature and bolted to trusses. Lagging consisted of two layers of 3x6-in., with joints broken, and covered over with No. 24-gauge black sheet iron. There were ten sets of centers built of steel and one set of timber. Each center weighed about 18 tons, complete, 74 ft. 6 in. and 77-ft. span. The centers were moved on four trucks built from the running gear or wheel bases of four Western dump cars and 60-lb. steel rails for frames, hung on U bolts from axles. In building the service trestle the height of these trucks was taken into consideration and trestle was built to an elevation below spring line, plus height of trucks, so that when centers were moved the bottom of cord of centers was level with top of trucks. This bottom cord of centers consisted of a 12x12-in. yellow pine, bolted to the



VIEWS OF CONCRETE ARCH VIADUCT ACROSS THE SUSQUEHANNA RIVER. 1—TRUCK RIGS FOR MOVING CENTERS; 2—CENTER READY FOR MOVING; 3—FINISHED ARCHES.

trusses. There were also 12x12-in. yellow pine timbers used to hold the two trucks in position to receive centers. Top of these timbers being level with bottom cord of centers, 2-in. iron pipe rollers were used to roll centers from under arches to trucks. The ten sets of centers were moved nine times and the one set of timber centers was moved three times. The average time required to move a set of centers was six hours, the work being done by the following force: One foreman, six riggers, engineer and fireman on McMyler crane. Each center displaced about 250 cu. yds. of concrete and cost about 7 cents per cubic yard of concrete. Prints show front and rear view of trucks with center in transit. Also finished half of

bridge in east channel of Susquehanna river. The bridge was built by the Robt. Grace Contracting Company, of Pittsburg, Pa., for the Cumberland Valley Railroad. Crosby Tappan, engineer of construction; F. B. Kennon, superintendent in charge for the contractor.

F. B. KENNON,
Atlantic City, N. J.

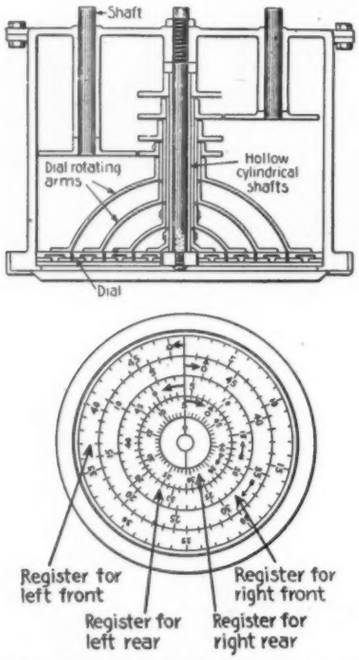
Measuring Loads on Truck Axles

Editor MUNICIPAL ENGINEERING:

Sir—In the operation of motor trucks it has been noted that most of the overloading trouble comes from having too much of the load on one of the springs while the others are perhaps underloaded. In other words, it is easy to determine the entire load on a truck but rather difficult to be sure that the load is distributed in just the proper manner.

Taking into consideration the fact that with every increase in load there is a flattening of each spring over the front and rear axles, it is apparent that the load might be, in a sense, measured by the distance between the axle and the apex of the spring. Each ⅛ in. depression might, for instance, indicate a load increase of 150 pounds. Thus a measurement system of gauging loads would be possible, but hardly practical.

Such a system forms the basis of a newly perfected dial indicator which registers for the driver the exact load on each spring of the truck. On each of the four axles is mounted a



INSTRUMENT FOR MEASURING LOADS ON MOTOR TRUCKS.

vertical rack. Pinions mounted on the side angle irons of the chassis mesh with each one of these racks. With this arrangement any variation of load over any part of the truck causes the pinions to turn by an amount which corresponds with the proportion of the added load that is put on each spring.

The motion from the four pinions is carried by bevel gears and flexible shafts along the chassis to the registering dial which is set in plain view of the driver. The mechanism of this appliance is shown in the accompanying sketch.

While the four weights to be indicated might be shown by four pointers, a movable multiple dial was chosen instead as being more easily read. In this device the dial face is divided into four concentric zones, each moving independently and each indicating the weight over a single spring. All the zones turn in the same plane, but adjacent ones move in opposite directions. Cleverly arranged concentric sleeve bearings allow each one of the zone dials to move freely, each being turned by gears operated thru the flexible shafts that lead to the four pinions.

During the operation of loading the driver has only to watch the dial, instructing the loaders to make whatever shifts are necessary to "line up" the four desired figures. If a total load of 6,000 pounds was to be put on it would be necessary to have in line the four "15's", each of which indicates a load of 1,500 pounds on its springs.

Variations of this idea have also been suggested, one being a piston and cylinder arrangement to operate the dials by hydraulic pressure, and another a system of steel tapes with spring take-ups to turn the indicator. Both of these are more complicated than the device described.

CHARLES H. SEAVER,
Chicago.

A Road Patching Machine

To the Editor of MUNICIPAL ENGINEERING:

Sir—The Los Angeles county road department has adopted the use of a small hand oiler, which is part of the equipment of its trucks as used in the maintenance of paved ways. The hand oiler is made of a sheet iron boiler about 2½ ft. in diameter and 3½ ft. long. It has a cast iron pot hanging in the center of the boiler, capable of holding 20 gal. of oil. A firebox surrounds the pot, which is used sometimes to keep the oil at a certain temperature. The boiler is supported between two iron wheels, and is so balanced that the center of gravity is below the axles, thereby always keeping the pot in an upright position. There is a handle on one side of the boiler, which is used to move the machine from one place to another. On the opposite side, and on top of the boiler, the hand crank for the oil pump is located. The oil pump is the most important part of the little heater, and is fastened to the bottom of the oil pot. The pump is a rotary pump and is driven by a sprocket and chain, which runs to the sprocket on the hand crank located on the top of the boiler.

Heat Applied Between Buckets

This pump is capable of a pressure of from 6 to 10 lbs. The pump is connected with a 20-ft. metallic ¾-in. hose, with a 3½-ft. piece of ¾-in. pipe at the discharge end. The pipe is plugged up with a plug having a slot cut in it so that the oil discharges in a spray. The pipe also has a throttle for turning on or shutting off the oil. The oil that is used in the heater is hauled to the various warehouses when hot and is put into 4-gal. pressed steel buckets. The oil cools very quickly and is cold when it is loaded on the maintenance trucks to be taken to the job. When the oil arrives at its destination the buckets are placed in two long rows on the ground, one upon the other, so that a fire may be built between the buckets and the oil heated to the necessary temperature.

Oil Heated by Distillate

Up to about two months ago wood was used to heat the oil, but at the present time the oil is heated by distillate and water burner invented by one of our foremen of paved ways gangs. The burner occupies very little room and oil is easily heated in 15 minutes to 500 degrees Fahr., during rain or shine. The burner is especially efficient in winter, as it does away with using wet wood for a fire.

With this new heater about eighty buckets of oil may be heated at one time. When the oil is heated to between 400 and 500 degrees Fahr., about 15 to 20 gal. are poured into the hand oiler. One man pushes the oiler to the spot to be repaired, another works the pump and a third man does the spraying of the oil.

On street oiling as much as 125 gal. per hour may be ap-

plied. The best results may be obtained from this hand oiler by heating the oil to about 500 degrees. By heating the oil to the above temperature it is not necessary to maintain a fire in the hand oiler.

This hand-oiling machine, after castings are made, is assembled at our mechanical shop.

F. H. JOYNER, Road Commissioner,
Los Angeles, Cal.

Speedy Street Sprinkling

Horse-drawn street sprinklers have been entirely done away with in Worcester, Mass., and a number of other cities in the vicinity, all sprinkling and flushing now being done for these municipalities by means of specially equipped trolley-car sprinklers.

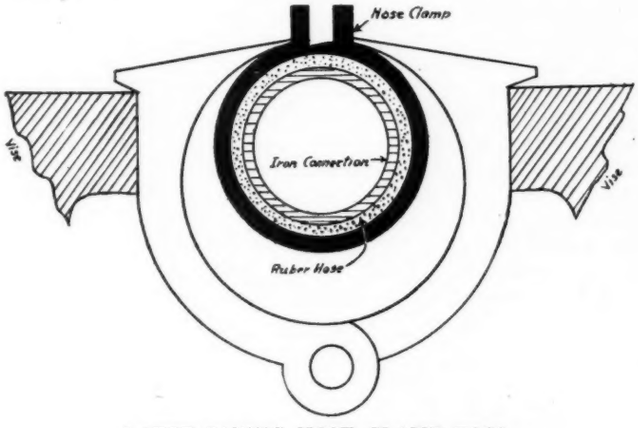
As operated by these cities the sprinkler, which is here illustrated, consists mainly of a suitably designed car fitted with tank of 2,900 gallons capacity, these tanks receiving their supply from specially constructed hydrants between the rails. Pressure for flushing is obtained by a centrifugal pump having a capacity of from 500 to 600 gallons per minute, this pump being operated at high speed by a large electric motor.

Nozzles in the electric flusher and sprinkler are so arranged that each nozzle picks up the refuse left by the nozzle before, the last nozzle beting attached to the swinging arm in such a manner that it carries the accumulation to the gutter. It is claimed that one car will cover from 10 to 12 miles of street in an 8-hour night, working from 10:00 p. m. to 6:00 a. m., when the street is clear from regular traffic. The amount of water used by this method of flushing is about 60 per cent. of that which would be used with wagon sprinklers to cover the same territory.

Tool for Applying Hose Clamps

To the Editor of MUNICIPAL ENGINEERING:

Sir—The simple device of which I am attaching a cross-section drawing is one that has been worked out to speed up the task of putting clamps on rubber hose. While the application of a single clamp does not require much time or effort, the shop where this device was worked out found that a great deal of time can be saved where hose splicing is a matter of daily routine. This is especially true if clamps happen to be an extra tight fit or the bolts are a little short.



LABOR-SAVING HOSE CLAMP TOOL.

As shown in the illustration, the device is a "U"-shaped clamp hinged at the bottom and large enough to accommodate hose from 1 to 4 in. in diameter. It may be forged in any shop with but little trouble. In applying a clamp to the hose to hold a connection, the pipe or connection is inserted in the hose and the clamp put in place. The device is then applied so that its jaws will grip the ends of the clamps and the whole is placed in a machinist's vise. By gradually closing the vise the ends of the clamp are brought together so that it may be fastened. In this way a connection for a hose may be made very easily and quickly.

L. SCHOOLCRAFT,
1907 Montrose Blvd., Chicago, Ill.

Locomotive Cranes on Sewer Job

To the Editor of MUNICIPAL ENGINEERING:

Sir—Locomotive cranes are now extensively used for municipal sewer construction, as indicated by the accompanying illustration. The photograph shows the orange peel bucket, which is utilized to advantage for hard earth, large broken stone and the like.

It may be stated that both the clam shell and orange peel type are equipped with cast steel shoes, or digging points. It

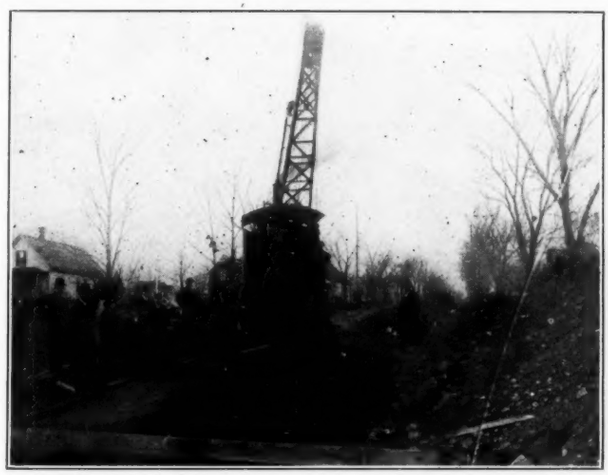


FIG. 2 LOCOMOTIVE CRANE WITH ORANGE PEEL BUCKET IN SEWER EXCAVATION.

is of interest to note that a cubic yard of dry sand weighs 2,700 lbs. and wet sand 3,400 lbs., while loose earth weighs 2,400 lbs. to the cubic yard and wet clay weighs about 3,000 lbs. to the cubic yard.

It may be stated that all of these locomotive cranes are of the revolving type, operated by steam. The lower traveling base or car body is formed of a heavy casting and structural steel, mounted on four wheels or on a pair of standard four-wheeled trucks. On the top is carried the large rotating gear and the turned roller path, upon which the upper base rotates.

The upper and lower bases are securely tied together by a hollow steel center pin, thru which is carried the vertical propelling shaft. The upper or rotating base carries all the machinery, boiler and boom, and is made of a single heavy casting. This construction is in every way superior to a built-up structure, as there is absolutely no possibility of the various parts working loose and throwing the shafting and other parts out of line.

It is claimed that all motions, except raising and lowering boom, are controlled by friction clutches. These are of the expanding steel spring type, and require practically no attention beyond keeping well oiled.

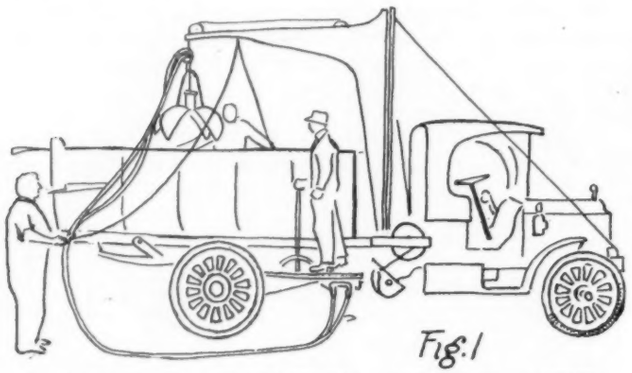
It will be noted that the engines are double and are reversible, with link motion. The cylinders and crosshead guides are cast and bored in one piece, to insure absolute alignment. The boiler is vertical, straight-flue type, and is heavily jacketed with asbestos and galvanized steel. The coal bunker and water tank are of steel, and have a capacity sufficient for a half day of steady running.

FRANK C. PERKINS.

NEWS OF THE NEW THINGS

By Charles H. Seaver.

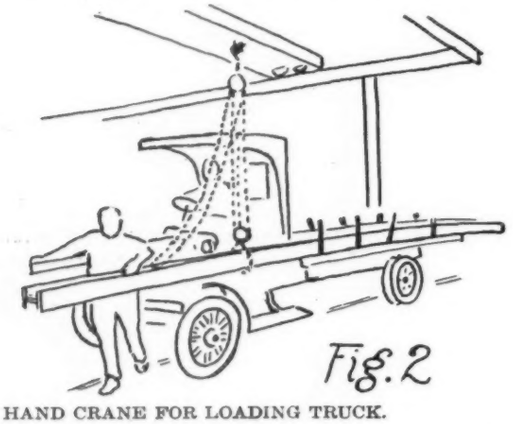
Among the ingenious labor-saving devices that have come to the aid of municipal departments affected by labor shortage is an orange-peel bucket dredge designed for cleaning out catch basins, the apparatus being self-contained and mounted on a dump-body motor truck. With this new dredge the difficult and extremely disagreeable work of cleaning catch basins by hand may soon be a thing of the past. In New



MOTOR TRUCK DREDGE FOR CLEANING CATCH-BASINS.

York, where one of the trucks is now in operation, it is doing the work of four-one-horse carts, while the three men replace nine men, and have a much easier time of it in the bargain.

In the main, the special equipment used consists (as shown in Fig. 1) of a steel arm, in the shape of an inverted "L", this being provided with a hoist operated from the truck engine. All the operations except swinging the arm into position over the manhole, are controlled by the driver, who, with a simple arrangement of levers, lowers the bucket into the catch-basin, closes the clamshell over its load, raises the loaded bucket and dumps the sediment into the truck.



HAND CRANE FOR LOADING TRUCK.

Loads Truck Without Traffic Hindrance

By means of a simple hoist rig (Fig. 2), long steel beams can be loaded on a motor truck without interfering with pedestrians in the slightest degree and without the almost complete stoppage of vehicular traffic that results when a long-wheel-base truck backs up to the curb to take its load. The truck shown is especially built for beams of extra length.

With the truck pulled close to the curb at the loading point, the beam to be put on is raised by a traveling crane and the crane carriage pulled out to a point well over the truck. The tracks of the crane are set high enough so that all loads can be raised to a height of at least 10 ft. above the sidewalk. This arrangement allows beams to be carried clear of the cab and put on the side of the truck farthest from the curb.

No power is used with this device, both the hoist and travel of the crane being controlled by hand. With practically the same equipment, electric motors can be added when loading is speeded to a point where the time element is of sufficient importance.

An Eight-Wheeled Truck

There is extremely little chance that the eight-wheeled truck (shown in Fig. 3) will fail to secure sufficient traction, even tho the roads may be too slippery or muddy for any other type of truck. This giant ten-tonner drives and steers from all eight of its wheels. In spite of the extra long body, the steering feature gives an unusually short turning radius that aids greatly in crowded or narrow streets.

Each of the two sets of four wheels that carry this new truck is mounted on a vertical spindle, similar to that used for the front wheels of the ordinary automobile or motor

EIGHT-WHEELED TEN-TON TRUCK.

truck. Power is carried to the eight wheels thru a long shaft provided with four worms, one of which turns each pair of wheels, each axle being provided with differential gears. This shaft is turned by a short chain belt working from a jointed extension to the motor shaft. To give further flexibility each axle is divided into three parts, all connected thru universal joints. By this arrangement the inequalities of the road are compensated for, and there is no chance of binding, even tho considerable inequalities are passed over.

Mud Doesn't Bother This Truck

It may safely be said that there is nowhere a road muddy enough or sufficiently sandy to stall the three-wheeled caterpillar truck shown in Fig. 4. This machine has the characteristic caterpillar "pull," but is so built as to retain a considerable amount of speed. Over good roads it will attain a speed as high as fifteen miles per hour.

While the new tractor is primarily built for "rough going," it will run on smooth, hard-surfaced roads, with no damage to the roadway, as the front wheels are equipped with pneumatic tires. These tires are mounted on wide steel wheels. This combination provides perfect resiliency for the higher speeds over good roads, and leaves in reserve a broad, flat steel rim for soft roads.

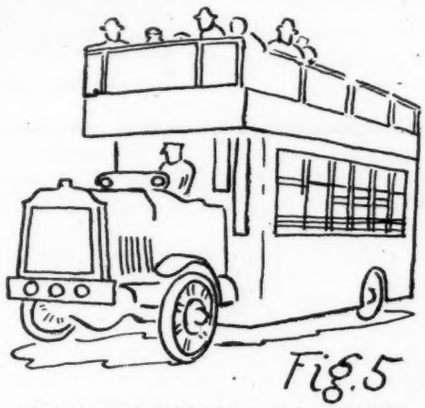
As an extra precaution against mired trailers, the cater-

THREE-WHEELED CATERPILLAR TRUCK.

pillar is equipped with a powerful winch, which can be driven independently of the caterpillar drive wheel. A tow rope and a strong pull with this device will drag a loaded trailer out of almost any difficulty imaginable.

Chicago's Motor Busses

Chicago's traffic problem, as far as it concerns the North and South Sides of the city, has excellent prospects of relief in the motor bus system which is now in partial operation. At present the busses run to the North Side only, and do not



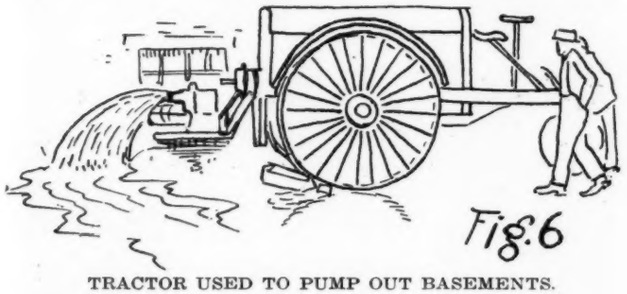
ONE OF CHICAGO'S MOTOR BUSSES.

maintain frequent enough schedules to make any marked decrease in traffic on the street cars during the morning and evening rush hours.

As shown in the accompanying illustration (Fig. 5), these big busses are of the double-decked type, carrying about twenty-five passengers on the upper deck and about twenty on the inside.

Tractor Runs Pump

A new use for a tractor was found a short time ago when one was called into service at Norfolk, Neb., to pump out flooded basements and cellars after an unusually heavy rain.



TRACTOR USED TO PUMP OUT BASEMENTS.

The tractor was pressed into pumping duty to get rid of the extra water after all other means had been abandoned. As illustrated (Fig. 6), the pump was set up at the basement window, and, with the tractor engine belted on, it made short work of its pumping tasks.

Build Track on Pipe

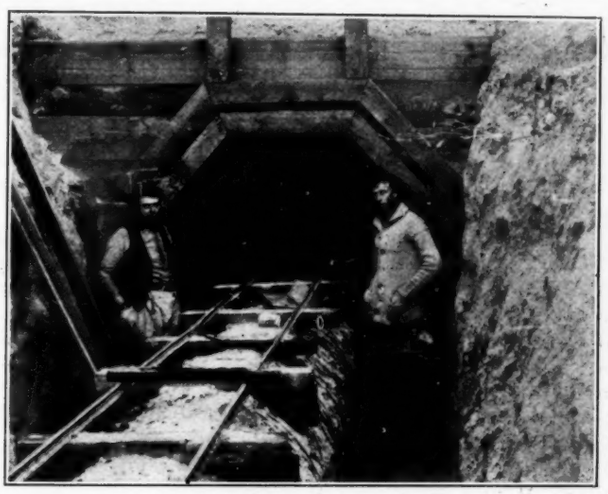
The Editor of MUNICIPAL ENGINEERING:

Sir—To aid in the removal of muck from the four tunnels carrying the Otay-San Diego pipe line, a unique railroad was built, the rails being laid directly on top of the pipe. This railroad was of material assistance in making necessary repairs, as the cleaning process, without some such transportation system, would have been slow and expensive.

The four tunnels carrying the pipe line have for the past eight years stood just as they were originally built, no cleaning or repair work having been done in that period. As a result the tunnel ends were clogged with debris, the drainage was seriously impaired, a good part of the pipe being partly covered with the water that seeped thru small leaks. The timber work was also badly rotted and broken away in many places. Water, mud and rotted wood combined in a slime that was rapidly ruining the pipe.

Prompt Action Necessary

Corrosion and pressure finally caused a bad break, which necessitated very prompt action. As a result, it was decided that the work of cleaning the tunnels and rebanding the pipe



TRACK BUILT ON PIPE LINE.

should be pushed forward with all possible speed. At first only a dozen men could be employed in the choked-up tunnel. As the work went on, more room was available and the "pipe line track" was installed to hurry along the job. A small dump car was used to carry out the muck. Power was supplied thru a cable, by a small hoisting engine, at the tunnel mouth.

C. A. FRANCIS,
Operating Department, San Diego, Cal.

State Highway Department Assistance

One of the most energetic road boards in the country is the road and bridge committee of the Milwaukee County Board in Wisconsin. During 1916 it carried on road and bridge improvements costing nearly $600,000. It maintains a large engineering staff and administrative offices and is in far less need of assistance from a state highway department than are the boards of most counties. Yet in its report for the last year it gives one of the best concise arguments yet made for a strong state highway department. The report points out that a state department is of much help in connecting the roads of the different counties into a united highway system, particularly in designating roads in a county which may not be important to that county, but are of importance to adjacent counties. The state department can also make surveys and maps better than the counties, particularly those which do not have enough such work to keep a permanent engineering staff. The state department is often able to obtain better freight rates than the counties can when acting independently, it can buy materials in large quantities and can test them when delivered, at lower prices than the counties can obtain, and it can bring to strictly local problems the knowledge and judgment acquired by supervising the road work of the whole state rather than a single county.

MISCELLANEOUS

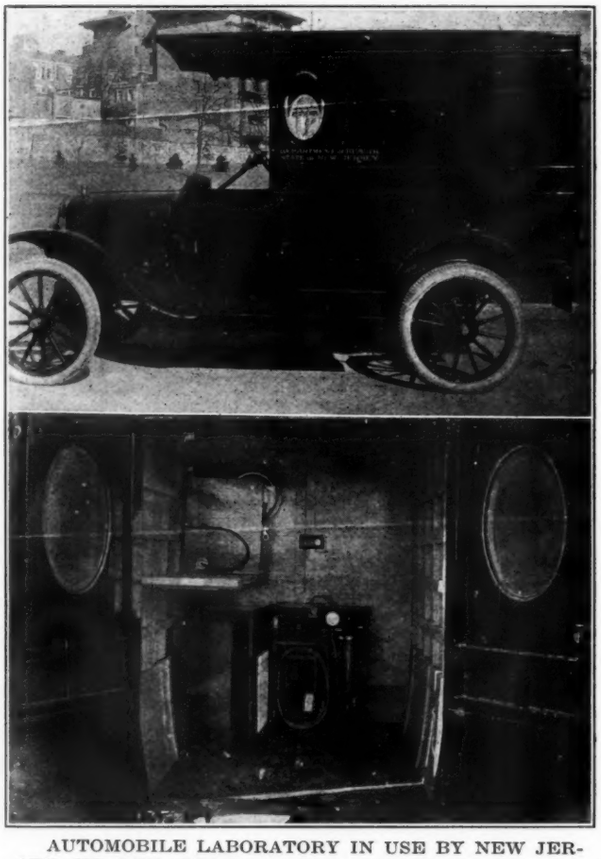
Traveling Field Laboratory

In New Jersey the supervision of the public water supplies, the majority of the sewage disposal systems, the pasteurization of milk and its products are intrusted to the State Department of Health.

The supervision includes, among other things, testing the efficiency of water filtration and treatment plants, sewage disposal plants and the various stages of the pasteurizing process by chemical and bacteriological examinations. To accomplish this work the department maintains a force of trained men who work from Trenton as a base, perform the necessary preliminary chemical or bacteriological work and return to the State Laboratory at Trenton in most every instance at the end of each working day, where such samples as may have been collected are turned over to the laboratory to be completed. It has been found that this system is troublesome, time-consuming and is not conducive to the best results. It frequently becomes necessary to make a week's test of the operation of a water filtration or sewage disposal plant, which has always been found to be attended with many difficulties. It has been shown on several occasions that it would be much better if the department had some means by which it could reach towns threatened by an unsafe water or milk supply more quickly than by relying on trains, which, in some sections of the state, are exceedingly irregular. The department, therefore, recently equipped an automobile with a laboratory and with the necessary chlorine disinfecting apparatus. The automobile is ready for service at any time, and should a water treatment plant become disabled and the quality of the water supplied to the public rendered unsatisfactory and unsafe, the plant can be reached within a comparatively short time and the chlorine gas apparatus installed and operated. The auto has a special body, which is of the same type as the body of a delivery wagon. It has wooden doors at the front, at the rear of the driver's seat, and at the back of the car, which are fitted with suitable locks. The interior of one side of the car is fitted with a laboratory bench and the necessary equipment for laboratory work. Two 37-deg. C. incubators were installed, in which cultures of bacteria can be grown. These incubators are made so that they may be either taken from the car and used on a 110-volt electric circuit, or they may be left in the car and run from a storage battery at 12 volts.

Experience has demonstrated that all places where milk is commercially pasteurized must be subjected to official control, which immediately presents a problem as to how this can best be accomplished. For nearly two years the department has endeavored to check up the various pasteurizing outfits by taking samples, for bacteriological examination, of milk in its raw state and at different stages in the pasteurizing process.

On examining the milk from creameries located in immediate proximity to the State Laboratory, samples after collection are brought to the laboratory to be plated, incubated and bacteria subsequently counted. In collecting samples from pasteurizing plants located some distance from the laboratory it is found impossible to deliver them there until long after closing hours. For this reason the necessary agar plates are made while at the creamery, the plates being brought back later in the day and placed in the incubator, where, after forty-eight hours' growth, they are counted by a member of the laboratory staff. This procedure is found quite satisfactory in all cases except in the extreme upper end of the state. Here the time spent in traveling to the various creameries, as well as the expenses incident thereto, makes the collection and transportation of samples under the plan outlined above impracticable.



AUTOMOBILE LABORATORY IN USE BY NEW JERSEY HEALTH DEPT. BELOW, INTERIOR OF CAR, SHOWING CHLORINE APPARATUS.

Generally speaking, the shorter the time between the collection and examination of milk samples, the more accurate will be the results. With the assistance of the department's new motor laboratory, which can be stationed at some central

point in the remote sections of the state, samples can be collected, plated and brought to the auto laboratory for incubation and counting. Besides effecting a great saving of time and expense, the general efficiency of the work will be materially enhanced.

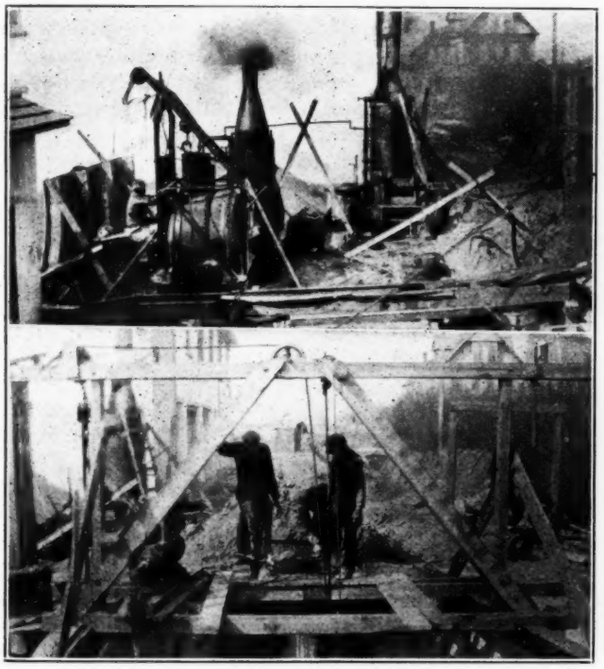
While this traveling laboratory was designed and largely planned by the chief engineer of the department, and will ordinarily be assigned to the work of the Bureau of Engineering, it is to be of service to the whole department, and may on occasions be also used for the control of epidemics of communicable diseases. One of the first uses to which the equipment will be put will be that of examining the milk and water supplies at the concentration camps of soldiers in the state of New Jersey.

Unique Gallows Frame and Hoist

By A. B. DePuy, Jr., Resident Engineer, Remington & Vosbury, Collingswood, N. J.

In connection with the construction of a sewerage system at Bay Head, N. J., it was necessary to sink a shaft 20 ft. in diameter and approximately 20 ft. deep, constructed of reinforced concrete with 16-in. walls. The shaft was built in two sections and each section sunk into place by excavating the interior, which was composed entirely of running sand.

In order to do this in a fast and convenient way it was necessary to erect a hoist over the shaft, as shown in the



CONCRETE MIXER USED AS HOIST ON BAY HEAD SEWER JOB. LOWER VIEW SHOWS FRAMEWORK ON SHAFT.

photograph. The timbers forming the cat head and braces are 2-in. by 8-in. and the posts and bottom stringers are 4-in. by 8-in., notched over two 8-in. by 10-in. timbers laid across the top of the shaft, with end resting on the walls. The whole structure was bolted together so that it could be taken down and reassembled with ease. Two shives were fastened to the top cat head, over which ran the lead, which ran thru a snatch block that hoisted the buckets. The snatch block and hook were balanced by a small counterweight which ran on two small blocks fastened to the cat head. Two buckets, made by sawing a pickle barrel in halves, and reinforcing each with wire rope, were used to haul the excavated material out of the shaft.

The lead from the gallows frame was fastened to the drum of a concrete mixer convenient to the work. This drum on the mixer is used to haul up the bucket by means of a cable run over pulleys on an overhead frame. The cable was detached from the drum and the lead from the gallows frame substituted in its place by running it thru a block fastened to the overhead frame on the mixer. The whole arrangement worked very satisfactorily, and both sections of the shaft were sunk in place without any difficulty whatever.

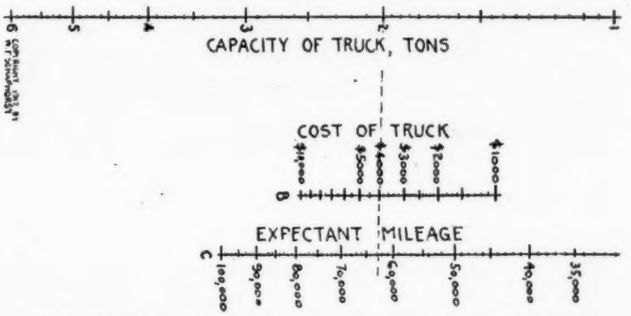
The water was pumped out of the shaft with a pulsometer pump operated by the boiler on the mixer and an auxiliary boiler on an old hoisting engine. The work was done under the direction of E. H. Gardner, superintendent for the Whiting-Turner Construction Company, of Baltimore, Md., contractors for the work.

How Many Miles From a Truck?

Mr. W. F. Schaphorst, M. E., Woolworth Building, New York City, puts it this way: "How many miles can you get from any truck?"

"Nobody can tell off-hand, beforehand or by sleight-of-hand, how far a new truck is destined to travel before consignment to the junk pile or junk dealer. At the end of 100 miles it may be completely ruined thru an accident. At the end of 5,000 miles it may be prematurely worn out thru recklessly poor care. Or, it may run 100,000 miles because of very good care, and still be good for more.

"So much depends upon care, therefore, that a strict mathematical determination of truck mileage is impossible. All that can be done is to build up a formula based on actual average service under reasonably good conditions.



CONVENIENT TABLES FOR DETERMINING PROBABLE TRUCK MILEAGE.

"This chart is based upon such conditions. It gives the mileage that can be reasonably expected from a truck of any cost between $1,000 and $10,000 and any capacity between 1 and 6 tons.

"Simply lay a straightedge across the chart as indicated by the dotted line, and column 'C' immediately gives the 'expectant mileage.'

"For example, what is the expectant mileage of a 2-ton truck costing $4,000?

"Connect the 2 (column A) with the $4,000 (column B), and the answer is, 'Nearly 63,000 miles,' in column C.

"This chart is not based upon the 'very best roads' nor upon the 'very best care.' It should, therefore, be possible to get even more than 63,000 miles from such a truck under the best of conditions. Under poor conditions such high mileage cannot be expected.

"If you now have a truck you will be interested in learning whether you are 'beating' this chart or if it seems to exact an extremely high mileage. Just lay a straightedge across and see."

Holds Expansion Joint in Place

By Guy Bonney, Baltimore, Md.

On a concrete road built by the Baltimore city water department, which was part of a new system of roads made necessary by the new dam, expansion joints were placed every 25 ft. apart.

The joints were formed by a pair of soft steel plates, between which was a piece of asphalt felt; each plate had lugs to form the band with the road slab.

To hold these places to proper line and grade and to allow the finishers to work over the joint, the contractor made a simple device which was effective and cheap, requiring only a 2-in. board, six strap hinges and a few bolts.

The board was long enough to reach clear across the roadway; one edge was cut to conform to the crown of the road, and at each end of the board was nailed a pair of wooden brackets, spaced to rest on the side frames of the slab and extending ½ in. below the cut edge of the board; one nail in each bracket, and driven partly into the road forms, held the board in place and ½ in. above the top surface.

Six 8-in. strap hinges were fastened to the board with their ends extending 3 in. below edge of same. Small bolts were used for the fastening, and the upper or outside strap of each hinge had one bolt passing thru it and the board; this bolt formed the clamping power and was placed near end of strap.

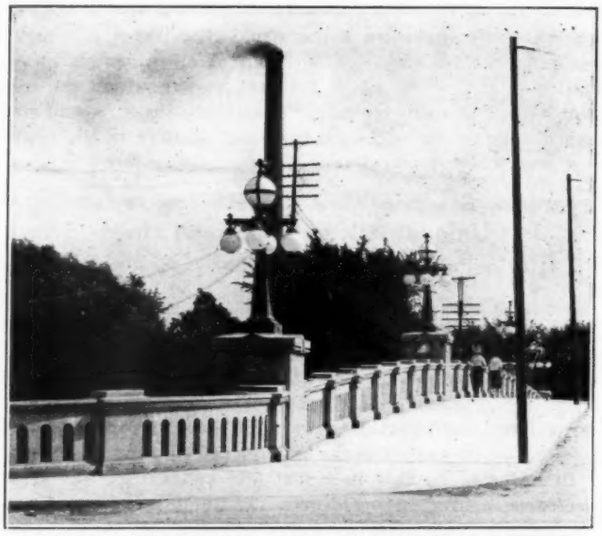
The holders were loaded with the plates on a bench. The plates were spaced ½ in. below the edge of the board with small blocks. The clamping bolts were then tightened and

PLACING EXPANSION JOINTS IN BALTIMORE ROAD. LOWER VIEW SHOWS HOW JOINT IS CLAMPED TO BRIDGE.

the hinge ends did their work well. The next step was the placing of the loaded boards at the required spacing. The removal of empty holders was easy, after concrete had set around the joints enough to insure no settlement of plates. It required the loosening of the one bolt in each of the four brackets. The holes left by hinge ends were filled by the finishers. Six boards were sufficient to keep the work going.

Ornamental Lighting for South Bend

After a failure of merchants to agree as to the operation of a co-operative system of street lighting in the down-town districts of South Bend, Ind., the city took over the illumination of this district late last year. The agreement made between the city and the Indiana & Michigan Electric Company, which



ONE OF SOUTH BEND'S NEW ORNAMENTAL LIGHTS.

supplies the necessary power, provides for the illumination of 214 lights, which are to be paid for at the rate of $45 per cluster per year and maintained by the lighting company.

Approximately forty arc lights have been eliminated by this agreement, and in their stead now stand the more satisfactory, and certainly more attractive, cluster lights. Each cluster contains five lights, four of them of 60-candle power and the single top light of 100-candle power. All of the clusters are similar except those at what are known as dead ends. At the end of each string of clusters the top light is of 250-candle power.

All of the five lights burn from the first darkness until midnight, but special provisions are made so that the top light of each cluster burns all night. This relieves the city of the necessity of relying on an occasional uncertain light for illumination during the late hours in the down-town section.

The accompanying illustration shows the new posts on the North Michigan street bridge, just at the edge of the business district.

Continuous Heat Raises Water Consumption

That long-sustained heat waves have a cumulative effect on water consumption is proven by the records of the Denver water department taken during the summer months. A six-day rise in temperature during July showed a daily consumption of 75,000,000 gal., a considerably higher figure than was reached on other warmer days which were not a part of a sustained hot spell. The maximum water consumption of the city of Denver last year was 77,500,000 gal.

Improved Oil Treatment for Roads

A new method of oil treatment that does away with the objectionable features of a newly oiled road is advocated by the New York highway commissioners. This process, which costs about $25 per mile, consists of an alteration of the material used to flux the asphaltum or pitch base. The flux used has about 50 per cent. of light volatile oils, which evaporate in about two days' time.

Personal

George D. Willets is now city engineer of Galveston, Tex., succeeding A. T. Dickey.

G. M. Lorraine, formerly city engineer of Orland, Cal., has been appointed city engineer of Alhambra, Cal. He takes the place of Charles Hewes, now city manager.

W. R. Koonce, former highway engineer of Houston county, Alabama, has been chosen to fill the same office in Pike county, of that state.

R. W. Whitaker was recently appointed city engineer of Bakersfield, Cal.

C. E. Johnson has been appointed city engineer of San Bernardino, Cal.

Arthur H. Blanchard, professor of highway engineering at Columbia University, was recently appointed consulting highway engineer to the Board of Water Supply of the city of New York.

Mark M. Trumbull, formerly in the service of the Illinois State Highway Commission as concrete and steel bridge specialist, is now assistant city engineer of Ottawa, Ill., and superintendent of highways for LaSalle county.

Charles M. Upham, Georgetown, Del., has been made chief engineer of the State Highway Commission. Mr. Upham was formerly county engineer of Sussex county and chief engineer for the Coleman du Pont Road, Inc. George W. Francis, Wilmington, a graduate civil engineer from Delaware College, has been appointed secretary to the commission.

Robert C. Terrell, of the department of civil engineering at the University of Oklahoma, has been promoted to the rank of associate professor, in charge of the new department of highway engineering as organized at that school. The new department is to be a branch of the School of Civil Engineering in the College of Engineering at the university. Mr. Terrell was formerly commissioner of public roads of Kentucky.

Charles H. Hurd, member of the Indiana Sanitary Commission, and formerly chief engineer and vice president of the Indianapolis Water Company, has been selected by the War Department as consulting engineer to take charge of the reconstruction of the water supply and sewage disposal plants at Fort Benjamin Harrison. The work involves the construction of a new 3,000,000-gal. water supply system to care for the men expected in September.

Dudley T. Corning, assistant engineer, Bureau of Highways and Street Cleaning, Philadelphia, Pa., has been appointed division engineer in the newly created Bureau of Street Cleaning. Mr. Corning was formerly civil engineer with the Cambria Steel Company, Johnstown, Pa., and manager of its subsidiary concerns, the Cambria Inclined Plane Company and the Manufacturers' Water Company.

George A. Duren, who has recently been appointed state highway engineer of Texas, was formerly resident engineer of the San Antonio & Arkansas Pass Railway, in 1903. Mr. Duren has made a careful study of roads and bridges in Germany, France, Belgium and England.

C. E. Hickok, recently with the United States Department of the Interior, has been appointed city engineer and superintendent of streets of Alameda, Cal.

Charles A. Mead, engineer of bridges and grade crossings for the Board of Public Utility Commissioners, New Jersey, has been placed in charge of the highway bridge work of the State Highway Commission, under statute provisions allowing such co-operation between state departments.

Ernest P. Goodrich has been appointed chairman of a subcommittee under the Council of National Defense, to investigate certain matters concerning cantonment location, design and construction. He has also been appointed director of the Bureau of Municipal Research of New York City and director for New York City of the military census of New York State.

James H. Von Wagenen has moved his headquarters from Washington, D. C., to Danforth, Me., in order to be near a number of surveying parties that are making surveys of the international boundary line between the United States and Canada. Mr. Von Wagenen was formerly one of the assistant engineers of the Illinois Highway Commission.

Mr. J. W. Hruska, who was formerly superintendent of highway work in LaSoeur county, Minnesota, is now engaged in a similar capacity in Waseca county, of the same state.

James H. Herron was made president of the Cleveland Engineering Society, taking office at its thirty-seventh annual banquet, on June 12, 1917. Mr. Herron has held a number of high positions in the engineering field, having been metallurgical engineer for the Detroit Steel Product Company, and, previous to that time, was commercial manager of the Bury Compressor Company, Erie, Pa. Mr. Herron is a member of the American Society of Mechanical Engineers, American Chemical Society and the American Society of Automobile Engineers.

Harold McCormick was recently made county engineer of Rathen county, Virginia, having resigned from the same office in Pike county, Ohio, to make his new connection. Mr. McCormick has been succeeded as engineer of Pike county by Joseph G. Bulmer.

W. S. Baver was recently made manager of the Clarksburg Engineering Company, a new organization of consulting, civil and mining engineers, which succeeded Alstetter & Wooters, of Clarksburg, W. Va. Mr. Baver was formerly assistant sanitary engineer of Johnstown, Pa.

Forrest J. Alvin, general manager of the United States Motor Truck Company, of Cincinnati, presided at a meeting recently held at the company's factory for the purpose of discussing motor truck construction features. Speakers at the meeting were: J. R. Phillips and Walter Jones, both of the Sheldon Spring and Axle Company. Many manufacturers and dealers in motor trucks in the Cincinnati district were present at the affair, which is one of a series of educational "get-together" meetings that are being held from time to time by the United States Motor Truck Company.

Meetings of Organizations

September 24-29, at Santa Rosa, Cal.—League of California Municipalities and Annual Public Welfare Exposition of municipal streets, street and road-making machinery. F. J. Erb, director of exhibits, Pacific Building, San Francisco. H. A. Mason, Secretary, 1120 Crocker Building, San Francisco.

September 27 to 29, at Chicago Norske Club, 2346 North Kedzie Boulevard, Logan Square, Chicago, Ill.—Informal Congress and Reunion of American and Canadian Engineers and Architects of Norwegian Birth or Descent. Joachim G. Giaver, chairman of local Chicago committee on arrangements.

October 17-18, at St. Cloud, Minn.—League of Minnesota Municipalities. Richard R. Price, Secretary, University of Minnesota, Minneapolis.

November 12-16, at New Orleans, La.—American Society of Municipal Improvements. Chas. C. Brown, Secretary, Indianapolis, Ind.

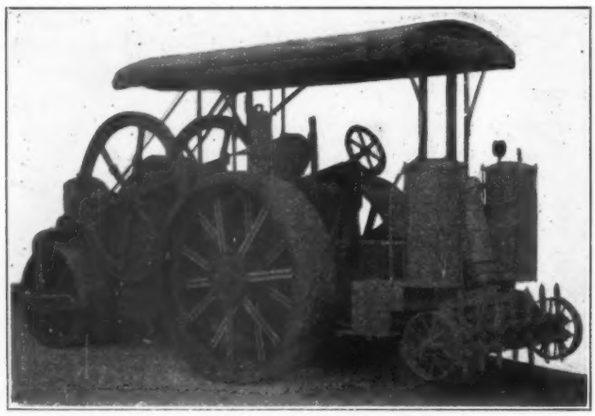
November 21-24, at Detroit, Mich.—National Municipal League. Headquarters, Hotel Statler. Clinton Rogers Woodruff, Secretary, 703 North American Building, Philadelphia.

MACHINERY AND SUPPLIES

A Pneumatic Road Scarifier

As an adjunct to the economical maintenance of earth, gravel and macadam roads, a Chicago manufacturer has perfected a novel pneumatic road scarifier. This scarifier is made up as an integral part of an oil engine driven road roller and is applied in such a way that the weight and power of the roller are most efficiently applied to the work.

The Austin-Western scarifier unit consists of a cylinder attached to the rear end of the roller frame, to which pressure



AUSTIN-WESTERN PNEUMATIC ROAD SCARIFIER.

can be applied from air storage tanks mounted on either side of the cylinder. The cylinder is connected to the scarifier by a connecting rod pinned at each end, which prevents any straining or twisting of the scarifier attachment, transferring undesirable vibration or strain to the cylinder itself. The scarifier attachment proper consists of a hinged frame hung on the rear end of the roller frame. This hinged frame is spanned by a steel yoke attached to the power end of the piston connecting rod, so that the downward pressure of the piston will force the scarifier teeth into the ground and keep them there during work, and by a simple reversing cock the pressure can be applied to the lower end of the piston and quickly raise the teeth out of work.

Cut Depth Regulated by Air Pressure

The air pressure is maintained in the tanks by a small compressor mounted on the top of the engine cylinder and operated by the engine from the crank shaft. A few minutes running of the compressor is sufficient to raise the air pressure in the tank up to 120 lbs. per square inch, which is ample for operating the scarifier, and a safety valve is supplied in the tanks, which blows off at that pressure. The tanks are tested to 300 lbs. pressure, so that they are absolutely safe. Tanks are also fitted with a pressure gauge and the compressor is fitted with an automatic cut-out, so that when the regular working pressure is reached the air compressor is automatically cut out, thus saving wear and tear and loss of horse power.

Operation Practically Automatic

As there are no hose connections or hinged joints in the scarifier described, there is no danger of air leakage, and it is claimed very little skill is required for successful operation and care of the machine. Movements of the scarifier casting are practically automatic. After the machine has once been lowered into the work, a fixed depth of cut is maintained without further attention. The air pressure provides a spring of perfect elasticity, which protects the roller and its parts from strain and vibration, even on heaviest work.

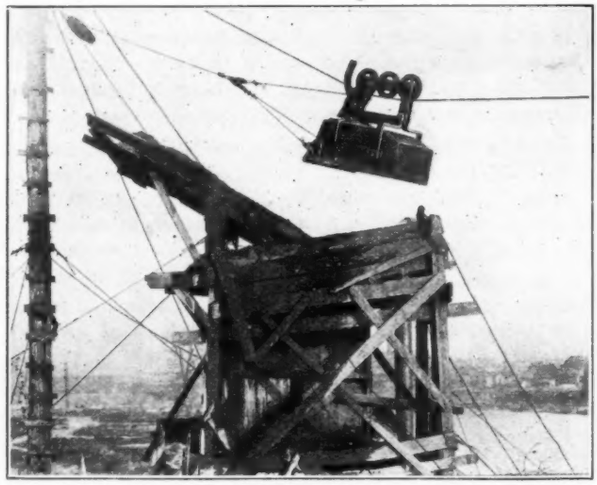
Special attention is called to the fact that the seven tynes or teeth are adjustable separately for wear and depth of cut, and are so attached that the loosened material does not clog up in front. The road wheels at each end of the scarifier simply act as guides or guards, so as to adjust the depth of cut and maintain an even and uniform work and to prevent the teeth from diving when soft material is met with.

Cable-Way Excavator

Application of the slack cable-way bucket here illustrated has resulted in a material decrease in the cost of carrying sand and gravel from a river back to a washing plant. This bucket is said to be very simple in construction and ruggedly built.

A curved latch carrying a heavy iron hook holds the load in the bucket during transmission. This latch is so pivoted that the greater part of the weight falls in front of the pivot center, insuring quick and sure locking of the bucket.

As the carriage is always erect over the bucket and is rig-



SLACK CABLE WAY EXCAVATOR WITH 3½ FEET CLEARANCE READY TO DUMP LOAD.

idly connected to it, the sheave bearings are not exposed to grit and dripping water, a fact which adds materially to their life. The bucket itself is of one-piece construction, with the exception of the back, which is riveted in. Loading is greatly facilitated by the smooth surface that is at all times presented.

Low Construction Cost Claimed

Construction costs incident to the installation of this excavator are quite low, owing to the simplicity of the rig. A considerable part of the total cost is consumed in the construction of the tower, which should be high enough to give a fall of from 10 to 15 ft. for each 100 ft. of travel.

Power may be supplied by steam engine hoist, by a gasoline engine double-drum hoist, or by an electric motor, where low cost power is available. Approximately 1-h.p. per cubic foot of bucket capacity can be figured where steam or electricity is used, and slightly more where gas-engine power is applied.

Portable Rock Crusher

The amount of haulage necessary on the average macadam or concrete paving job has been materially lessened by a portable rock crusher, which is light enough to be transported easily, but has the strength necessary to crush the hardest rock used for paving. This crusher, which is here illustrated, is known as the "Acme."

In the main, the Acme Crusher consists of a 50-ton portable bin mounted on steel wheels; a solid steel jaw crusher carried on an all-steel truck; and a folding bucket-elevator to carry the crushed stone from crusher to bin. In transporting the rig the bucket elevator is folded back over the crusher, the bin truck then being hooked up to the crusher truck and transported as a trailer.

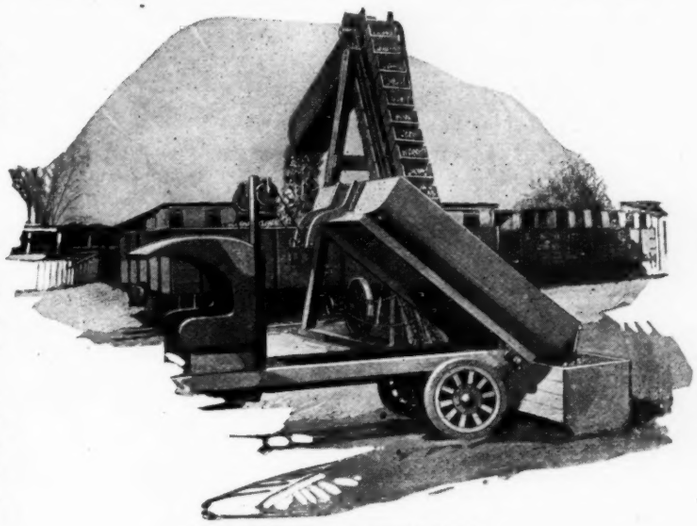
One of the special features of the "Acme" outfit is the fact that the crusher parts are made of open hearth steel. Jaw and lever are cast, while shaft, eccentric and roll are made of special carbon steel, hammered and turned to size. It is this feature in particular that makes the crusher especially strong in spite of its light weight.

Several sizes of this portable crusher are manufactured, these having capacities of from 8 to 300 tons per hour.

Automatic Car Unloader

One of the latest devices for unloading and loading sand, gravel, crushed stone, slag or other loose material for road work operates on the reciprocating bottom principle in conjunction with a chain bucket. An all-steel feeder, which fits between the ties under the car to be unloaded, is fitted with an engine-driven bottom plate, which moves back and forth a distance of 11 in. with each stroke of the crank shaft, carrying material out with each stroke and delivering it into the chute which carries it to the buckets on the elevator. The material is carried in a continuous stream to the buckets, filling them evenly to nearly their full capacity. The buckets of the elevator are made from sheet steel and are 16 in. wide, while the feeder is but 12 in. As there are always two buckets underneath the end of the chute of the feeder, it is impossible for any material to be discharged into the bottom of the pit.

Power is furnished to the elevator by an 8-h.p. engine, which is connected to the jackshaft by a steel roller-bearing chain, thereby eliminating all belts. Control of the elevator is secured by a friction clutch on the engine shaft. A spiral jaw clutch on the jackshaft allows the feeder to be started or stopped at will.

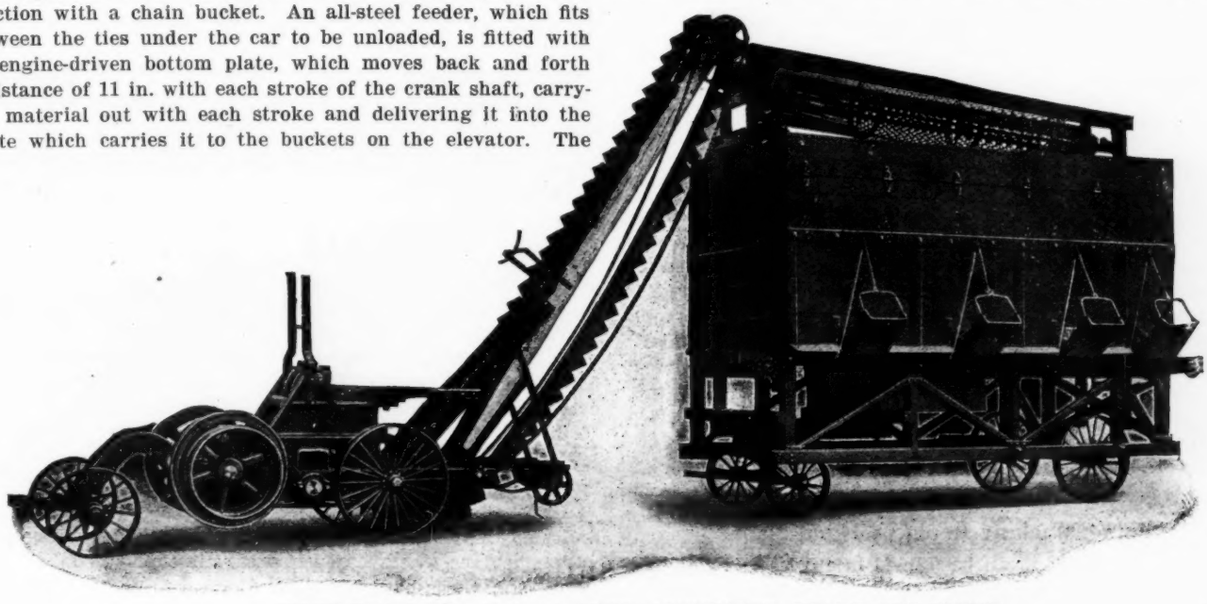


AUTOMATIC CAR UNLOADER.

Their 25-ton wood bin is easily erected and taken down. The three large openings in the bottom provide for quick loading, only 15 to 20 seconds being consumed in loading a two-yard dump wagon.

Counterbalanced Concrete Chute

Concreting of large areas has been put on an efficient basis thru a system of counterbalanced chutes recently perfected. With these chutes the economical working radius is greatly increased and the point of discharge is easily shifted up and



FIFTY-TON PORTABLE CRUSHER CONNECTED READY FOR WORK.

down the tower. By the use of counterbalanced structural steel sections the entire weight of two or three chutes can be supported by a single steel tower. As the sections and tower are structural steel, they are erected and dismounted easily, and are a valuable part of a contractor's permanent equipment.

Claim is made that a gravity plant of the kind described will save at least five men where the concrete to be placed per hour amounts to 10 yds. On a 20-yd-per-hour job, 10 men

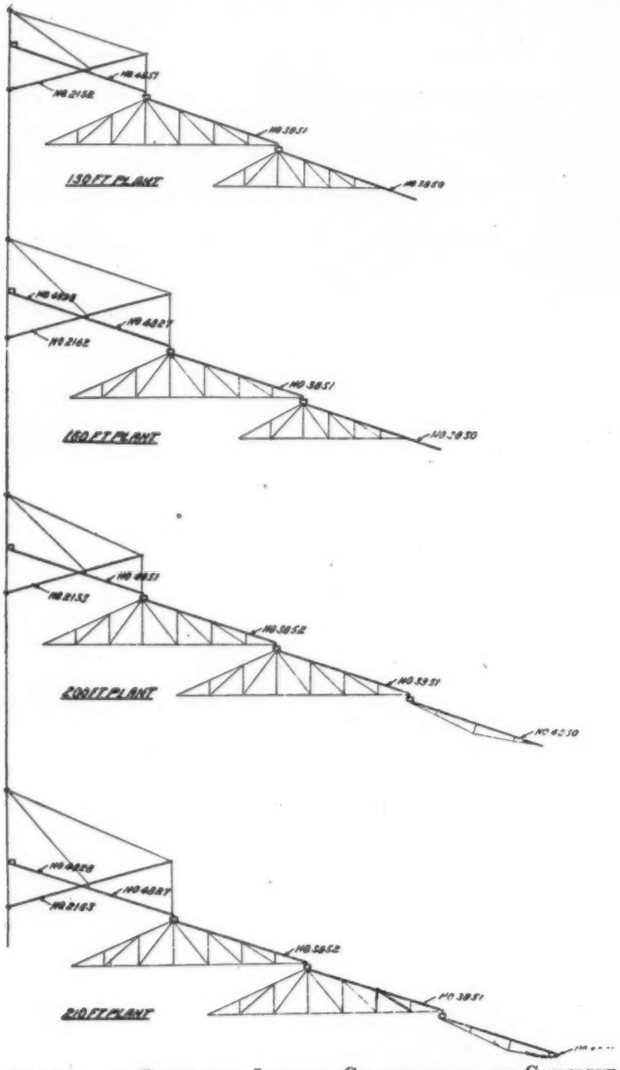


DIAGRAM OF DIFFERENT LENGTH COMBINATIONS OF CONCRETE CHUTING TRUSSES

could be dispensed with, as compared with the older concrete placing methods.

It is also found that properly mixed concrete is handled to better advantage in the chute than the sloppy too-thin sort. This stimulates the use of concrete mixed to a plastic consistency. In addition to the advantage given, the counterbalanced system entirely does away with wheeling over a green concrete floor, which so often permanently injures the structure.

The accompanying diagram shows how the counterbalanced sections are suspended to make chutes of different lengths.

Gaining Machine Replaces Hand Labor

More bridge timbers can be framed in a day, it is claimed, with a recently invented power framer, than could be handled by six skilled adze men. The new machine is especially adapted to the work of framing ties and guard rails for railroad bridges, but can be used on practically any timber framing job.

As illustrated, the entire machine is made up as a compact unit, mounted on narrow gauge car. Power is applied

POWER GAINING MACHINE.

by a 4-h.p. gasoline engine, this power being transmitted to a cutting head by belt. The arm on which this head is carried can be adjusted to any depth of cut by means of a screw wheel regulator.

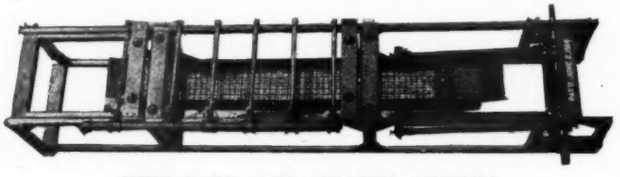
A second narrow gauge car running on a truck at right angles to that which carries the machine is used as a bed for timbers being cut.

In starting on a job the arm of the gaining machine is set for a cut of proper depth and clamped to hold the cut. The machine is then moved up to the work and thru the cut by means of a hand lever attached to one of the wheels of the car. Each cut made by the head is 2 in. wide and very clean. After each one the material car is moved a distance of 2 in. and a new cut made until the proper width of cut has been obtained. By repeated trips of the cutter, any depth or width of mortise can be secured.

This labor saver was invented by J. E. Toohey, of Grand Rapids, Mich.

A Compact Gravel Screen

The compact shaker sand-and-gravel screen here illustrated is 18 ft. long, 3 ft. 2 in. wide and 3 ft. 8 in. high, and has a daily capacity of 400 cubic yds. It is of steel construction, self-contained and readily portable, as it weighs but 3,600



NEW SAND AND GRAVEL SCREEN.

lbs. equipped with the spray washer. The top, of 2-in. mesh, takes the oversize; the second is of ¾-in. mesh; the third mesh is 4 per inch, and is for roofing gravel; the fourth is 10-mesh for topedo sand; and the last of 24-mesh takes fine sand. These screens, which are made in 400 and 600-yd. units, operate at approximately ½c per yard for power.

Replacing Men on Maryland Job

Unusual factors forced the contractors constructing the Salisbury-Ocean highway in Eastern Maryland to replace men with machines wherever such a substitution was at all possible. Labor was hard to find, and owing to unpleasant work-

ing conditions, chief among which was a plague of mosquitoes, it was extremely difficult to find men who would stay on the job long enough to be really useful. Teams were exceedingly hard to get.

Owing to a lack of roadmaking materials in the neighborhood, this 13-mile road was built of concrete, another feature which helped cut down the hard labor. Specifications called for a single course highway, 14 ft. in width, with 5-ft. shoulders, making the overall width 24 ft. A 1:2:3 mix was used, this being laid 7 in. thick in the center and 5 in. thick at sides, all on a flat subgrade. Expansion joints were of Barrett roofing and were spaced 60 ft. apart.

Getting Material to the Work

Local conditions made the question of bringing up materials a rather complex one. Most of the work could be reached only by hauling over the subgrade, which was of a soft sand or loam that made cartage extremely difficult. For this reason any plan of haulage by team would probably have failed, even if teams in sufficient numbers had been available. A much more efficient plan of handling the material was worked out by the McNerney Construction Co. (Contractors), of Canton, Pa., who had the work in charge. This plan provided for the carriage of stone, sand and cement from a railroad which paralleled the new road at a distance of half a mile. Along this railroad track three base points were selected, work being carried on from one point at a time.

At each point in turn a ten-car railroad siding was laid and an unloader installed. A narrow gauge track was then laid parallel to the siding, this being so placed that the unloader could easily handle the materials from the flat cars to the industrial dump cars. The industrial track looped back to the road work, the rails being laid down on steel ties in the middle of the subgrade. Sand and stone were dumped on either side of the track, leaving room for forms at the edge. Cement piles were spaced 50 ft. apart.

Efficiency methods were carried thru every phase of the work. A Koehring No. 16 mixer was used, this being supplied wtih material by specially designed push cars. These cars, two in number, were built of steel, with a partition extending the entire length of the body and dividing it into bins. For the proportion desired the ratio in this case was 2:1, but the partition was made removable, so that other mixes could be measured. Loading at this end was done by hand shovelers, stone going into the large bin and sand to the small one. Two bags of cement were used to each carload of sand and stone. A double track beginning at a point about 10 ft. from the mixer provided for switching the loaded car past the empty.

About 30 men were kept busy at the work of mixing the concrete and finishing the work. These were divided as follows:

Foreman	1
Engineer	1
Fireman	1
Shovelers (stone)	8
Shovelers (sand)	4
Car pushers	3
Charging hopper	2
Placing concrete	3
Template men	2
Finishers	2
Utility man	1

A total of nearly 140 men were employed on the job.

Loading Machine Lowers Costs

As a result of replacing slow, expensive hand shovelers with a loading machine, a large manufacturing company reports that it has effected a saving of a little more than 15 cents per cubic yard on the sand and gravel handled. This saving is exclusive of supervision and overhead charges, showing merely the difference in economy between the men and the machine.

Carefully compiled cost records kept by this concern compare as follows:

COST OF LOADING BY HAND LABOR

Loading wagons, 8 laborers, 3 yds., 13 min. at 25c	$0.435
Loading auto truck, 8 laborers, 2½ yds., 10 min. at 25c.	.415
Cost of auto truck at $1 per hour	.160
Cost per 5½ yds	$1.010
Cost per yd	.184

COST OF LOADING WITH MECHANICAL LOADER

Loading wagons, 2 laborers, 3 yds., 4.8 min. at 25c	$0.040
Loading auto truck, 2 laborers, 2½ yds., 4 min. at 25c	.033
Cost of auto truck at $1 per hour	.066
Power at ½c per cu. yd	.028
Oil, grease, interest on investment	.010
Cost per 5½ yds	$0.177
Cost per yd	.032
Cost per yd., hand labor	$0.184
Cost per yd., machine	.032
Amount saved per yd	$0.152

An additional saving was made on this work, due to the fact that a wait of 10 to 30 minutes between loads, as it existed with the old method, was entirely done away with. Elimination of this wait resulted in a saving of from 20 to 60 cents per load or from $3 to $9 per day. The expense incident to time lost between loads was reduced by about 75 per cent. with the installation of the machine.

MECHANICAL LOADER CARRYING GRAVEL DIRECT FROM PILE TO TRUCK.

Loads Direct from Pile to Truck

As shown in the illustration, the loader used in making the comparative cost tests consists of a gas-engine operated bucket elevator, mounted on a substantial four-wheeled steel truck. Electric motors are supplied where this form of power is preferable.

A patent crowding device with which the rig is equipped pushes the elevator medium into the material 30 in. without moving the wheels of the truck, making the machine dig as well as elevate and eliminating the necessity of laborers shoveling the material into the buckets. The elevator medium can be tilted down when desired.

Claim is made that these machines will load trap rock that will pass thru a 4-in. ring, sand, gravel, coal, coke, ashes, and any other material capable of being handled with a shovel.

Gasoline Tractor for Road Work

As a result of the application of the 6-cylinder gasoline engine to a road tractor, a small but quite powerful machine has been produced. It is known as the "American." This tractor, which is here illustrated, is powered with a 70-h.p. engine, and owing to the steady drive obtainable from this power source, will handle a string of loaded trailers with ease. Three steel wagons, each containing 15 yds. of crushed stone, made up the load at a recent trial of the tractor. This load of 25 tons was pulled up a considerable grade to the point where the crusher was located.

Transmission and Brakes

The transmission of the new tractor is of the selective type—three speeds forward and reverse—mounted on frame directly behind the motor. All shafts and gears are of nickel steel. Bearings are die cast of best grade of Babbitt metal. There are three (center) bearings on each shaft. All gears are extra large. The gear shifting mechanism is entirely enclosed in the oil-tight transmission case.

The brake drum is mounted on an extension of the secondary shaft just outside the transmission case. The brake is operated by the same lever which operates the clutch, being so linked that the action of releasing the clutch applies the brake.

The drive shaft is mounted on roller bearings carried in brackets bolted to the lower side of the frame. Mounted on this shaft are the steel drive gear and the chain sheave, the whole being entirely enclosed in a steel case, which protects the driving parts from injury and dirt.

Drive to the front and rear axles is thru an adjustable chain made from the highest grade of vanadium steel forgings. The feature of this drive is that the working surface is between the outside of the chain link and the pocket in the sheave wheel, and permits steering of axles without interference or loss of power each link is adjustable for stretch and wear and self-locking.

Semi-Floating Axles Used

The axles, semi-floating, are identical, and made entirely of steel, differing only in the method of attaching to the frame. The axle shafts are of nickel-steel, carried in roller bearings of ample size, four bearings used in each axle. The differential used in general automobile construction is here replaced by the chain sheave, which carries the differential pinions.

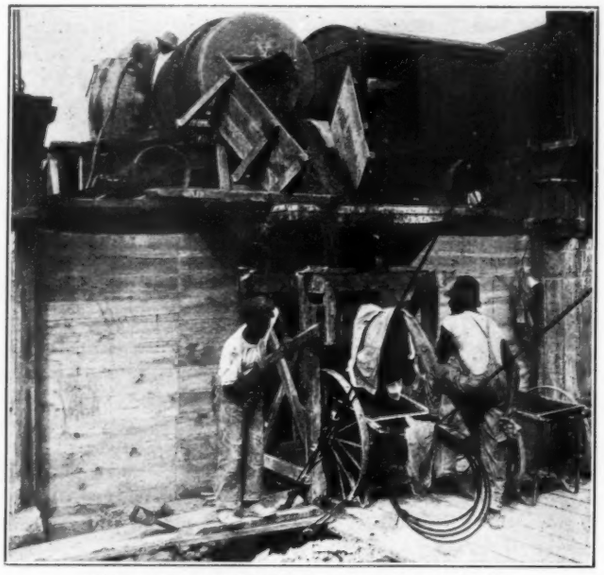
GASOLINE TRACTOR WITH TRAILER TRAIN.

The rear axle is mounted in a large ball-bearing fastened to the frame, thus always maintaining the relative position of axle and frame. The front axle is mounted to frame with a ball and socket joint; the axles are self-lubricating.

The wheels are provided with angle-iron rims fastened together by means of drop-forged cleats riveted across the face of the wheel at an angle of 22°. Each wheel has thirty spokes and eight pull rods, all of which are always in straight tension. The pull rods do all the driving, leaving the spokes to carry the load only. The face of the wheel between the cleats is left open to prevent clogging with mud or snow.

Portable Mixers Used to Serve Distributing Towers

The Chicago Junction Railway Company has under construction at Thirty-ninth and Canal streets, Chicago, a large general warehouse covering a ground area of 287x200 ft. The structure is to be five stories in height, with an unusually deep basement, and the George A. Fuller Co., executing the contract, are using three distributing towers as the principal



PORTABLE MIXER CHANGING HOPPER.

means of conveying the mixed concrete. Time is an important factor in the construction of this building, and as a means of speeding up the work the distributing towers are served by portable mixers.

For mixing the large quantity of concrete required in the footings and walls for the street foundation and the footings for the numerous central columns, two low charging mixers are used, one of 10 cu. ft. and the other of 16 cu. ft. capacity. After the street foundation walls were completed the mixers were mounted directly on these walls for supplying concrete for central foundation footings. When placed in this manner the mixers discharged directly into hoppers from which the concrete was gated into carts for distribution. The mixers were moved along the walls as the work progressed, so that it was not necessary to wheel any of the concrete a great distance. The accompanying illustration shows the manner of discharge from mixer to hopper and gating the concrete from hopper to carts.

In explaining the use of these portable mixers as a means of increasing the rapidity of placing concrete on this large construction job, Mr. G. A. Sawyer, Jr., Chicago Manager of the George A. Fuller Co., said that he was first among the engineers of his company to use the portable mixers. In the construction of the Harvard University dormitory buildings the concrete had to be placed over a large area, and for his purpose he used portable mixers and moved them along as the work progressed. The economy effected was so great that he has since used them wherever construction work offered similar conditions.

Photos and statistics by courtesy of the Standard Scale & Supply Co.

Recently compiled statistics show that only 21 per cent. of the water used by the city of Chicago passes thru meters. The average daily water consumption in Chicago is 620,000,000 gallons, or about 249 gallons per capita.

Portable Vise Standard

A portable vise standard and pipe bender that can be used to advantage both on old and new work has recently been placed on the market. This combination tool is strongly made, the body being constructed of heavy sheet iron, se-

MARTIN BENDER PACKED FOR CARRYING.

curely riveted and well braced with angles. The legs are made of ¾-in. pipe and are widespread to give a firm working place. Legs are easily removable. Each standard is equipped with either a chain or hinged vise.

When pipe is inserted in the vise, to be either cut or threaded, the bender at the rear end acts as a guide. The bender will handle all sizes of pipe up to ¾ in. in diameter, and it is claimed will positively not kink the pipe. The legs

MARTIN BENDER READY FOR USE.

are so set that the stand can not be upset when threading pipe or in bending the largest size. The No. 16 gage side braces form a convenient place for hanging wrenches, cutters and other tools of a similar nature.

The device is known as the "Martin" Portable Vise Stand and Pipe Bender.

Material Chute on Shore Tunnel

The Milwaukee (Wis.) Water Department is having a special shore tunnel built at the new Linwood avenue intake off Lake Michigan. Owing to the difficulty of reaching Shaft No. 2 by either wagon or motor truck, a steel-lined material chute (see photograph herewith) has been erected to convey the cement, stone and sand from the unloading platform, at the hilltop, to the cement shed and the mixer platform at the base of the hill. This chute is placed on an angle of 30° 16′ 40″ with the horizontal. It is 90 lineal ft. in length, 46 in. wide by 21 in. deep, and is made of 2-in. plank, with bottom lining of 18-gage sheet steel.

Near the lower terminus of the chute, says L. G. Warren, the resident engineer, a two-way diverting branch was placed, and there a swinging gate enables them to divert the cement

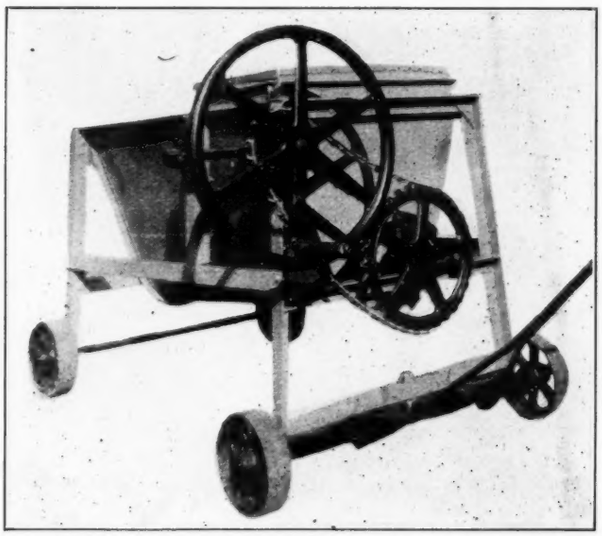
MILWAUKEE, WIS., WATER DEPT. SHAFT NO. 2, LAKE SHORE TUNNEL.

to the cement storage shed, or the sand and stone direct to the mixer platform. The unloading platform (note photo) is provided with a 6x6-ft. trap door, giving ready access to the chute. All materials except wet sand prove to flow readily on the 30° angle, but it requires a man to give wet sand a little extra impetus to get it to slide properly.

Grout Mixer Lowers Paving Cost

Claims of perfect uniformity in grout mix, at a much lower cost than has been possible with hand mixing, is made for a power-driven grout mixer, invented by A. W. D. Hall, City Engineer of Jackson, Mich. While the illustration shows a hand-drive arrangement, a 1½-h.p. gasoline engine is recommended as a saver of power supply.

One of the principle features of this machine is a paddle wheel at the bottom of the agitating chamber. This wheel,



GROUT MIXER AS OPERATED AT JACKSON, MICH.

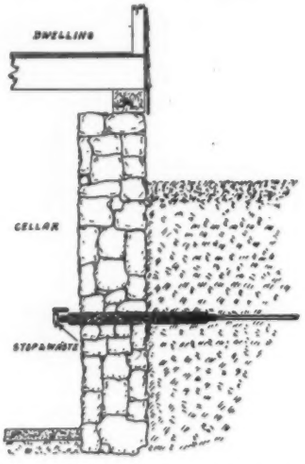
turned by the main drive wheel thru a chain, insures uniform mix.

Cement and sand are placed in a two-compartment hopper at the end of the mixer nearest the flywheel. These compartments each have a capacity of 1 cu. ft. Gravity carries the ingredients to the mixing chamber, at which point water is added. A hand-operated valve at the outlet regulates the supply of prepared grout.

It is claimed that the hand-driven machine will mix a batch of 1 cu. ft. of sand and 1 cu. ft. of cement in two minutes or less, while with the engine drive this time is reduced to 30 or 40 seconds.

Cement Coated Water Pipe

To protect iron pipe from corrosion at the point where it passes thru the cellar wall, a concrete coating is now provided. This keeps the pipe from direct contact with ground

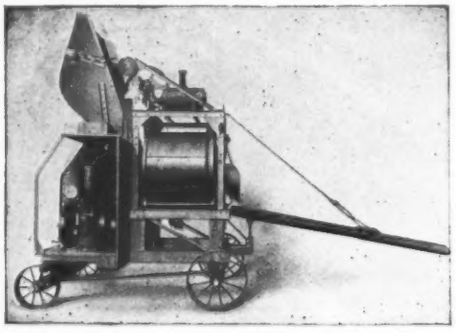


SECTION OF "CELLARWALL" CEMENT COATED PIPE.

water outside the cellar wall and protects it from condensation inside the wall. The pipe section as supplied is 3 ft. 6 in. in length, wrought iron, and is coated to a depth of ½ in. with neat cement. The device is known to the trade as "Cellarwall Service."

Portable Concrete Mixer

Several mechanical features which add to the efficiency of the small paving job have been perfected in a compact concrete mixer that is now being marketed. This mixer is de-



BANTAM CONCRETE MIXER.

signed especially for handling alley, driveway and small road jobs.

This new "Bantam" machine is a one-bag batch mixer and is equipped with an open-end pivot hopper, with dumping bar for quick charging. The compensating hoist sheaves, which raise this hopper, apply the maximum speed as the hopper approaches a vertical position. The hoist is equipped with an automatic knock-out which prevents damaging the hopper and permits the operator to turn his attention to other duties. The automatic water-measuring tank, similar to those installed on standard Ransome mixers, facilitates quick and efficient operation.

The paver discharges thru a 10-ft. distributing chute which is entirely clear and unobstructed by cross-roads of any kind. This gives the chute a clear swing of practically half a circle.

The mixer end of this chute is 3 ft. 11 in. above the ground, permitting a fairly steep slope when desired. An intermediate gate in the chute facilitates even spreading of the concrete.

The power unit is a 4 h.p. gasoline engine. A belt drive is used. The paver is regularly furnished without traction gear, but if desired a suitable traction gear can be provided. With the traction drive a 6-h.p. engine is installed.

Universal Sand Tester

Realizing that the value of sand as a building material is largely dependent upon its structure, a demand has been established among contractors for definite advance knowledge of the sand to be used. This knowledge is quickly and authoritatively supplied by a small sand tester that has recently been perfected. With this device, an absolute determination of grading is furnished, and an indication of the cleanness is given.

The "Universal" sand tester consists substantially of a graded series of standard mesh screens (Nos. 6, 10, 20, 35 and 65), placed in a series of communicating glass vials, as illus-

UNIVERSAL SAND TESTER.

trated. The whole arrangement of vials is water-tight, so that the wet test can be carried out.

For making the test a small metal measure is filled with the sand to be used, this measured quantity of material being poured into the top vial, which is then filled with water to a point above the first screen. The instrument is then shaken until the sample under test has been divided.

Determination of percentage is then made by marking on a record card the height of the sand deposit remaining in each vial. This height is marked in percentage on the card, so that the percentage of sand retained by each screen is read direct, making calculations unnecessary and giving an accurate and authentic record of each test.

FIRE DEPARTMENT

Chicago's Electric Fire Boats

Two boats of rather unusual interest form an important part of the fire-boat squad which for some years has been stationed in the Chicago river, protecting Chicago's river front. These are the twin boats, "Joseph Medill" and "Graeme Stewart," both electrically operated. Principal dimensions of the craft are: Over-all length, 128 ft.; beam, 28 ft.; depth of hull, 15 ft.; draft, 9 ft. 6 in. Steel construction is used thruout except for a small amount of inside finish of deckhouse and pilothouse. Water-tight bulkheads, water-tight hull compartments and strongly reinforced bows constitute construction features worthy of note.

Steam Turbines Supply All Power

While the boats are propelled by electric motors, the prime source of power on each is a steam turbine, the same one which supplies power to the pumps. This arrangement allows a maximum use of the equipment, as the pumps are not required when the boat is under full headway, and vice versa.

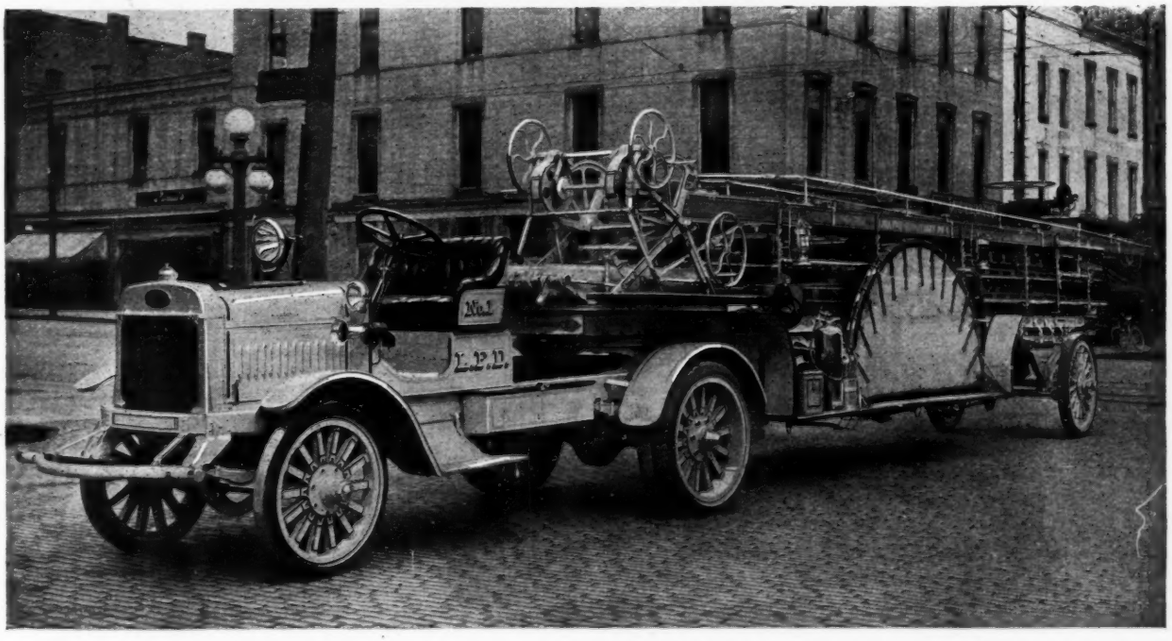
Two centrifugal fire pumps take care of the pumping requirements on each of the twin boats. These pumps are two-stage, and are each capable of supplying 9,000 gal. per minute against a pressure of 150 lbs. to the square inch. By means of a branch pipe arrangement the discharge of one pump may be connected to the suction of the other, so that the set is, in effect, a four-stage pump. With this connection a 5,000-gal. per minute stream is delivered at 300 pounds pressure. Coming from a 3½-in. nozzle, this stream has a tremendous fire-fighting efficiency.

Turbo-Generating Equipment

Power for each pump is supplied by a 660-h.p. Curtis turbine, each turbine shaft also carrying a 200-kilowatt direct-current generator. The electric power generated is carried thru suitable control apparatus to the two 250-h.p. direct-current motors, one being connected directly to each propeller shaft. As the motors are of the variable-speed reversing type, the movements of the boat are controlled with remarkable nicety. Independent turbine sets operate the exciters.

How the Boats Operate in Service

Getting under way with the electric fire boats is an extremely simple matter. The engineer starts his turbines, circulating and air pumps, while the captain turns the controller that regulates the speed of the screw motors. On the run to the fire all the power of the turbine is available for driving the boat, as the fire pump impellers are simply turning in their



HORSE-DRAWN AERIAL TRUCK, MOTORIZED WITH A 3½-TON GRAMM-BERNSTEIN TRACTOR. OPERATED BY THE CITY OF LIMA, O.

casings. Arriving at the fire, the engineer has only to open the sea cocks, letting water into the pumps.

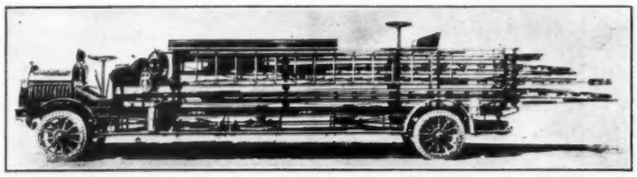
Electric operation of fire boats as applied in Chicago's twin installation has many features to recommend it. One important advantage of electric over direct steam drive comes from the fact that the propellers cannot race, even when rough going carries them clear out of the water at times. The motors used run at a constant speed, whether running fully loaded, partially unloaded or entirely free from load. Damage to propellers and to the boat itself is prevented in a great degree by automatic circuit breakers, which open the motor circuits the instant a certain degree of overload is reached. Thus in moving down the ice-filled river, if the propeller blade happens to strike a large block of ice, the motor automatically stops, saving the propeller from damage. In a similar manner the motors are stopped in case of a collision with a dock or another boat.

Dredge Spuds Moor Boats

On account of the fact that a considerable portion of the river water front is without dockage facilities (the buildings extending clear to the water edge), some means of positive, speedy anchorage had to be provided. For this service spuds designed somewhat on the order of dredge spuds were installed. Four of these spuds are provided, two forward and two aft of each boat, these being made of double thick steel pipe 18 in. in diameter, shod with cast steel points. Steam power is used for raising and lowering the spuds.

Harrisburg Buys Powerful Truck

Two powerful ladder trucks, both of the type here illustrated, have recently been added to the equipment of the Harrisburg, Pa., fire department. In these trucks power is applied at all four wheels, with the result that the front wheels pull just as strongly as the rear ones. Utilization of all power generated by the motor accounts for the wonderful showing of these Duplex trucks. Power wastage is practically elimi-



DUPLEX LADDER TRUCK, AS OPERATED AT HARRISBURG, PA.

nated. Applying the power in the Duplex with twice the effectiveness possible in rear wheel drive trucks gives the Duplex tremendous reserve power and makes impossible the stalling of the truck in hub deep mud or on steep hills.

"The Duplex is known in many fire departments as the truck that goes anywhere," said H. M. Lee, president of the Duplex Truck Company, of Lansing, Mich. "Fire chiefs who have installed the Duplex assert that it is the most dependable truck built; that it is always on the job."

MACK CHASSIS, EQUIPPED WITH HOOK AND LADDER EQUIPMENT, AS OPERATED BY THE CHICOPEE, MASS., FIRE DEPARTMENT.